RADIO AND HOBBIES IN AUSTRALIA

APR 42

POST WAR RADIO

WAR is a tragic and regrettable business, particularly war as we know it today. Families are broken up, ambitions are shattered, and people and nations see the work and toil of years disappear in a fury of flame and smoke.

However, war provides a new and urgent incentive to the scientist and the research worker, and, whatever the other effects of this war may be, we can rest assured that it will open up vast new scientific fields for peacetime exploitation.

Perhaps the most obvious and the most spectacular progress has been made in the realm of aviation. The last three years have witnessed tremendous advances in the design and production of heavier-than-air craft. If the war lasts, as seems likely, for a considerable time, still greater advances will be made. The bomber of today will be the transport plane of tomorrow.

No less real has been the progress in radio. Witness Britain's radio-location. Outside the Services, little is known of the system, apart from its general outlines.

It is known to utilise the ultra-high frequencies, well above those normally used for short-wave broadcasting. Signals of a special nature are transmitted in the required direction, and reflections from a ship or plane in the range of the beam are intercepted by special receiving apparatus.

Radio-location equipment is in constant use along the foreshores of Great Britain and by other Allied Powers. Its use, moreover, is not confined to shore stations, and the principle is being successfully applied to aeroplanes and, doubtless, to ships and certain land vehicles.

That Germany is also using a form of radio-location is evidenced by the recent raid by Britain's Commandos on a radio-location post in France. The possibilities of the system in peacetime need no emphasis.

There is another point. The study of radio-location will probably lead to a better understanding of wave propagation at very high frequencies.

This may, in turn, accelerate the development of television, which seemingly must come, despite the many statements minimising its value as an entertainment medium.

England was making good progress with television before activities were suspended "for the duration." America is carrying on and effecting improvements to existing technique.

Another interesting development in America is the propagation of high-fidelity, noise-free programmes on the high frequencies, utilising the principle of frequency-modulation. The problem of achieving the best possible range is the same as with television.

Indeed, it seems that after the war we shall see many new developments in the art and application of radio communication. Let us, therefore, fervently hope and strive that we might be as free to pursue our investigations in the future as we have been in the past.

INDEX

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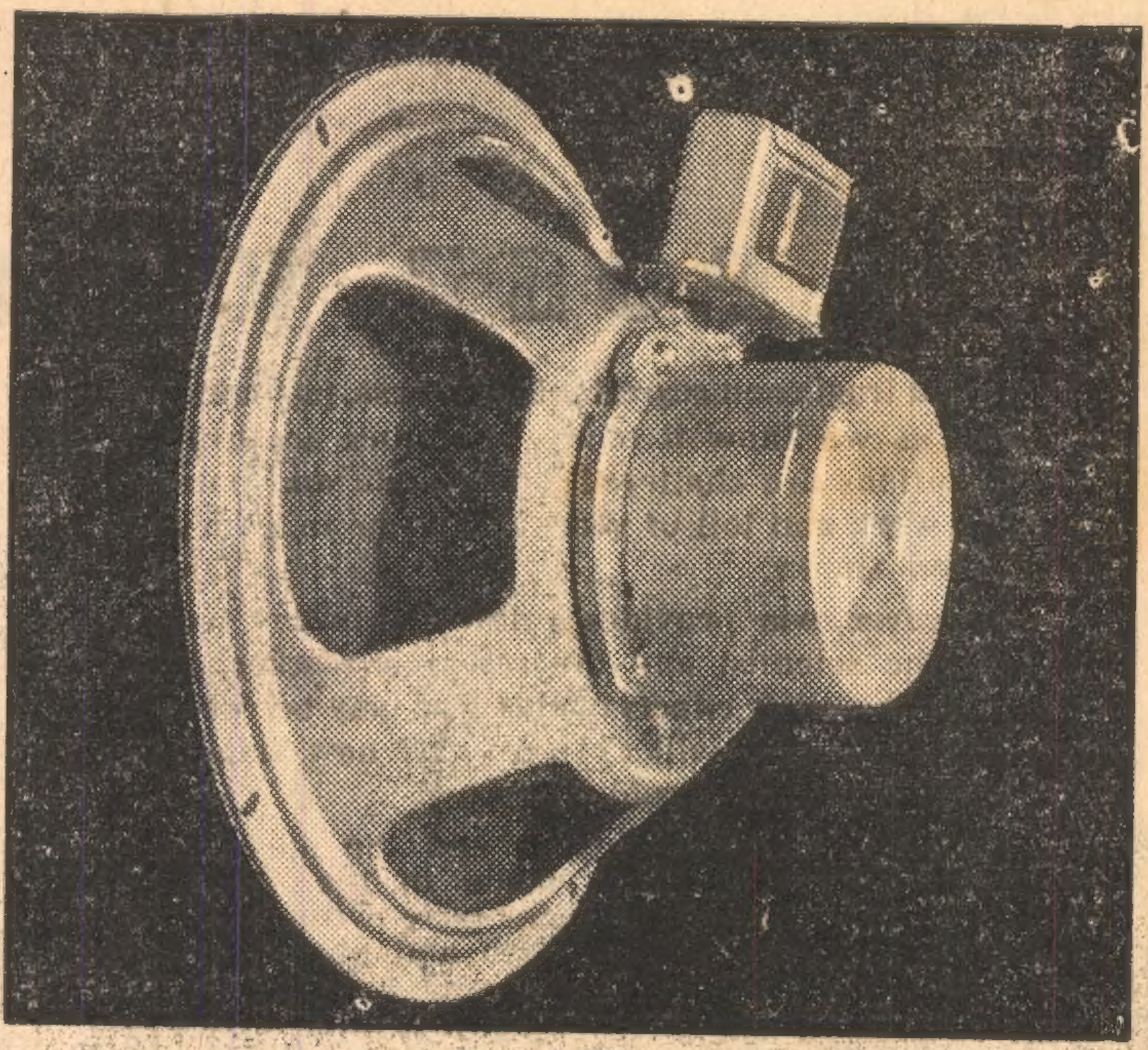
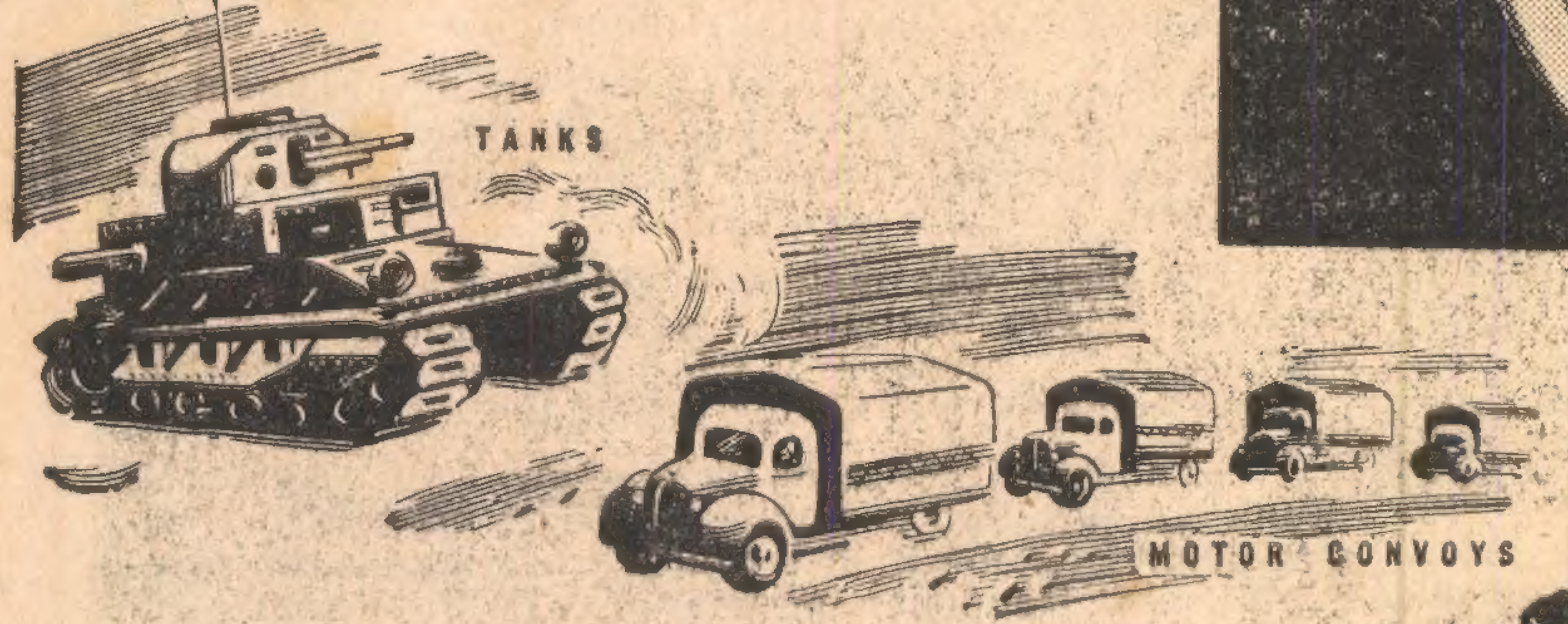
"Orders are Orders!"

and they come clear and undistorted through

ROLA

LOUD SPEAKERS





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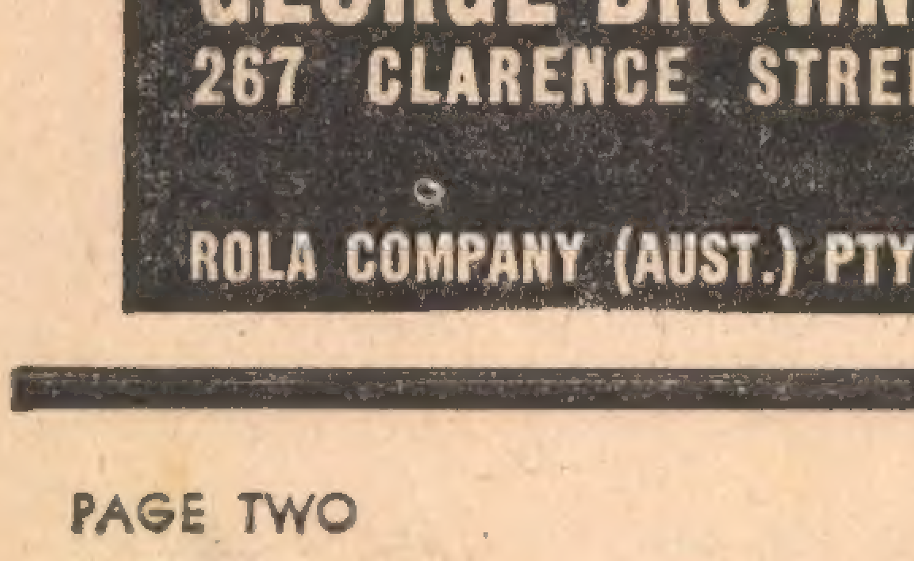

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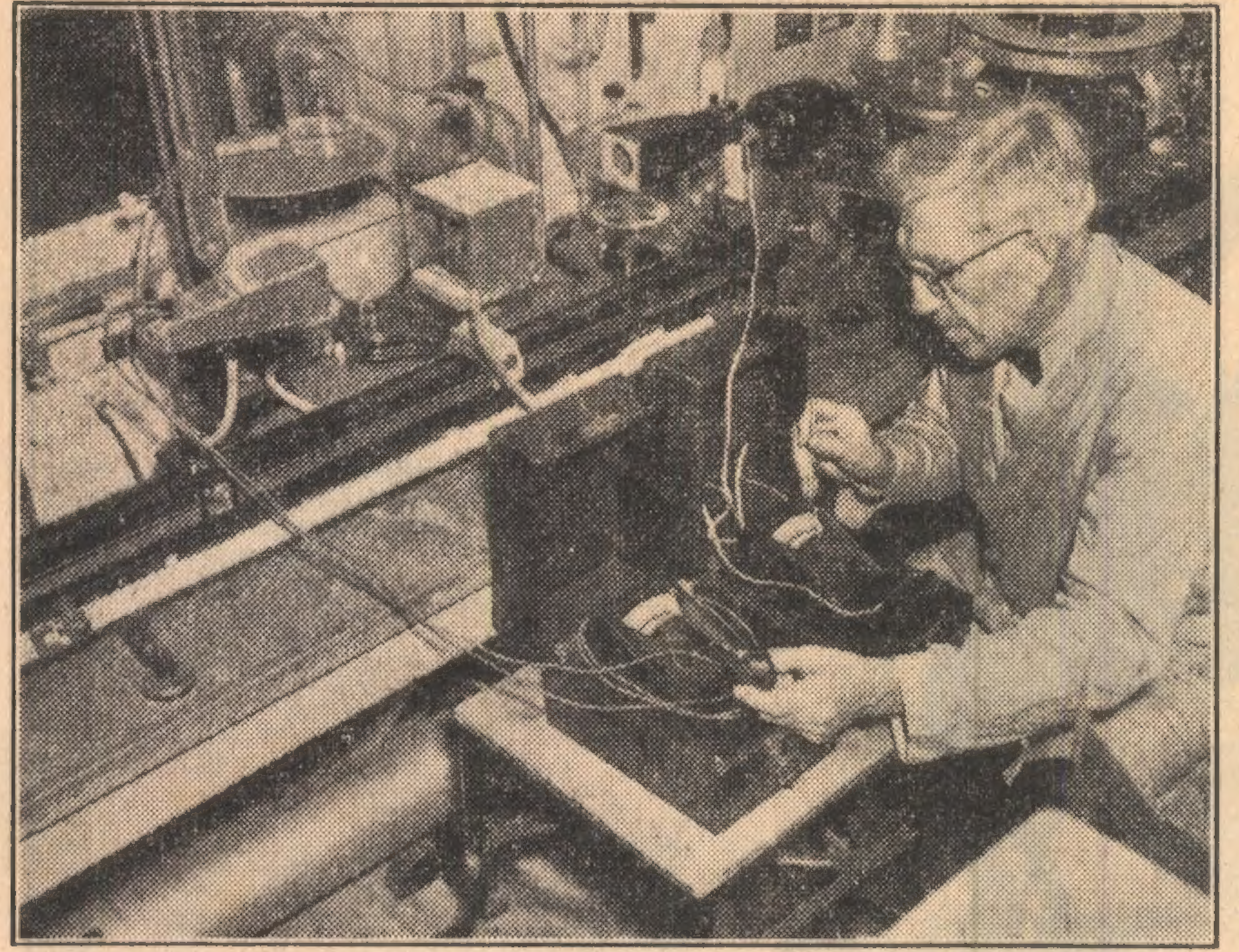
THEY MUST CARRY ON—GAS OR NO GAS

Thus far, poison gas has not been used in the present war. However, a possible gas attack must not hinder the work of the Air Force. Accordingly, the ground staff at British aerodromes are trained to perform their normal duties in full gasproof clothing.

IT'S WORTH MILLIONS—IF IT WORKS!



Many of the items for which patents are granted are simple gadgets and devices, whose worth is apparent at a glance. Other items, notably chemical substances and manufacturing processes, are not so obvious and their worth is only apparent after exhaustive and intricate tests. Here, the Californian scientist, W. F. Adler, is conducting tests on a new chemical which has the property of increasing heat absorption and irradiation of surfaces to which it is applied.

If you are an average Australian and haven't invented anything yet, the chances are that you've an idea in your head about some gadget, which is going to "make millions" for you —when you can find time to get it working. Perhaps when you do, you will really make millions. It's been done in the past and still is being done. But the chances are that you won't.

by

L. B. Montague

INVENTIONS are seldom worth as much money as their proud parents think. Of course not all inventors are unreasonable in their demands. Some are quite modest! For example, there was the American farmer who obtained a patent on an attachment for mule harness to hold up the trace chains. He only wanted £30,000 spot cash!

Then, again, there was the cobbler in a small Ohio town whose customers were continually coming to him to get their rubber heels fixed so there wouldn't be a gap between the edge of the rubber and the leather heel to catch dirt and snow.

The trouble, the cobbler decided, was that the heels were perfectly flat on both sides. If they were made concave on the inside, convex outside, nails driven into the middle would press the edges of the rubber into tight contact with the leather heel and keep them there.

He had no money to pay a patent attorney or patent office fees, so, after talking the idea over with some shoe salesmen, who raised some money, he "cut in" a patent attorney on a one-twelfth interest in his invention in lieu of a fee.

When the patent had been granted the group of potential capitalists decided not to try to sell the patent, but to go into business for themselves as distributors of the new rubber heels.

They sold the heels direct to cobblers and shoe stores. Before long they were making their own nails for fastening the rubber heels to shoes; later they set up their own factory to make cartons for shipping them. They sold the Canadian and English patent rights for something like a half-million dollars.

They had the usual experience of patentees in protecting their rights against infringements. They won sixteen such actions in all.

The original founders of this particular business all made "millions." If you want to make a million from your gadget, invent something simple and cheap for which there is a wide demand.

SIXTEEN YEAR MONOPOLY

If your idea is novel and useful and you have devised a practical method of making it work, then the Government, if it finds that no one else has done the same thing the same way, will grant you a monopoly of its producion and use for a period of sixteen years. After that it becomes public property.

But, however useful your basic idea may be, anyone else who has the same idea and finds a better way of making it work may do so. In that case you're out of luck. For you can't patent an idea; you can only patent a particular and specified way of putting it into practice.

Long before the Wright brothers invented the first practical aeroplane, men had flown. What the Wrights invented and patented was a method of controlling flight by warping the wings of a biplane.

WRIGHT V. CURTISS

Glenn Curtiss, working independently on the same age-old idea, invented a different method of wing-control, the hinged aileron. The Wrights sued for infringement, but the courts held they had no patent on flying, only on a particular means of flying. The Wrights and Curtiss pooled their patent, after much litigation and under wartime pressure from the US Government.

A sixteen-year monopoly gives one the right to prevent anyone else from using an invention, but it does not give one the right to use anyone else's invention. If you devise an improvement on an earlier invention, and it's a really useful improvement, you can probably sell or lease your rights to the owners of the prior patent—but not for millions.

Most of the valuable improvements on existing devices or processes are made by inventors working in the industry to which they pertain. If you are an employee and have invented an improvement on a machine or process used by your employer, the patent rights belong to you personally, unless you have been employed specifically for the purpose of making inventions.

SALARIED INVENTORS

In that case you are not entitled to anything but your wages or salary, though it is not uncommon, in the larger industries maintaining research departments, to give a research worker or team of workers a bonus for inventions. The employer cannot patent an employee's invention in his own name

THE ENDLESS QUEST FOR NEW IDEAS

unless he is the actual inventor and his employees have merely carried out his instructions in doing the mechanical work.

Obviously, a company cannot invent anything, so the workers in industrial-research laboratories, such as Du Pont, General Electric and Westinghouse, apply for patents in their own names, but assign them to their companies.

INDEPENDENT INVENTORS

So many of the important inventions in recent years have come out of the industrial-research laboratories, with the inventors practically anonymous, that the belief has grown up that the day of the small independent inventor has passed.

The elaborate equipment needed for much research in the electrical and chemical fields, generally for financial reasons, is not available to the lone worker. The tendency towards the control of monopolies through patent rights granted to huge corporations is regarded by many people as constituting a very real danger to our social order.

So far, at least, this danger is largely an imaginary one. Not only are the majority of patents still granted to individuals, with no assignment strings attached, but some of the largest fortunes from patents are still being made by independent inventors.

CARLETON ELLIS

Edison, for example, patented 1099 inventions in his own name before he died, but did you ever hear of Carleton Ellis, one of the most prolific of living inventors? He has taken out more than 750 patents on his own inventions, according to the latest count, and is still inventing at the age of 65.

Ellis studied chemistry at the famed Massachusetts Institute of Technology, and he was just twenty-one when one day he observed some workmen trying to remove paint from the woodwork of a house. The chemical they used left the wood discolored.

Young Ellis thought he could make a better paint-remover, tried his formula in the laboratory and found it worked. He applied for a patent and got it. He borrowed £100, and, with a factory equipment consisting mainly of three barrels in an old shed, started making paint-remover, while two university companions peddle the product to painters and builders.

BIG BUSINESS!

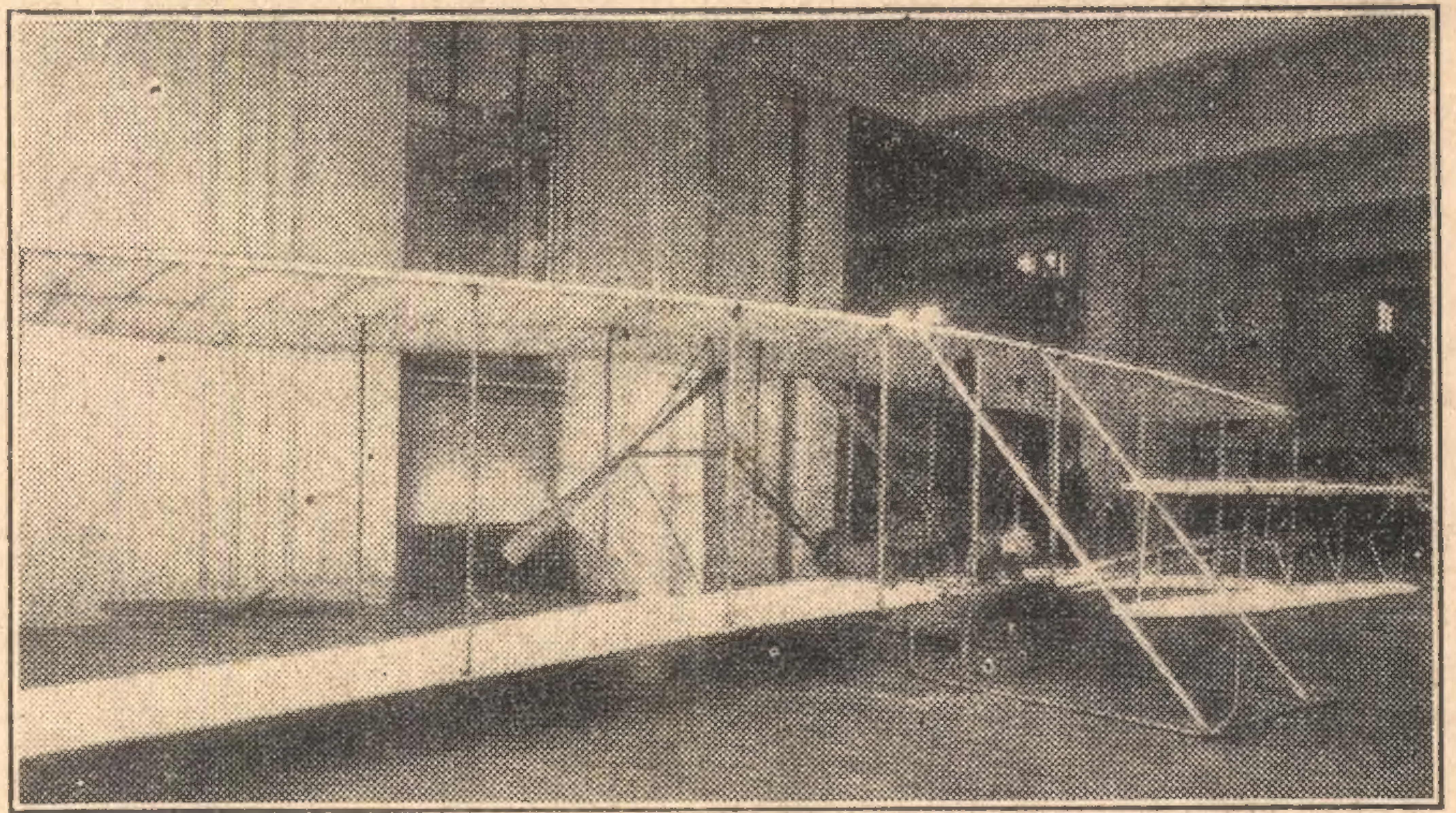
Ellis sent samples of his paint-remover to the railway companies and one responded with an order for a car-load!

Ellis' next idea was that the world wanted a paint that would never need to be removed, but would last forever. He is still looking for it; but in the meantime he has invented new paints, varnishes, lacquers and other coating materials that have revolutionised the paint industry. He has his own laboratory and staff of technicians, but, like Edison, he is the real inventor.

In the Patent Offices of the capitals of the world there are always crowds of inventors, patent attorneys and professional searchers busy examining the records of every patent that has ever been issued.

If an invention is not too obviously like something which has previously been patented by somebody else a patent attorney will draw up the specifications and have drawings prepared so that anyone with the necessary technical knowledge can make the device, or combination of matter, for which originality is claimed.

That is the price you pay for your temporary monopoly—complete and de-

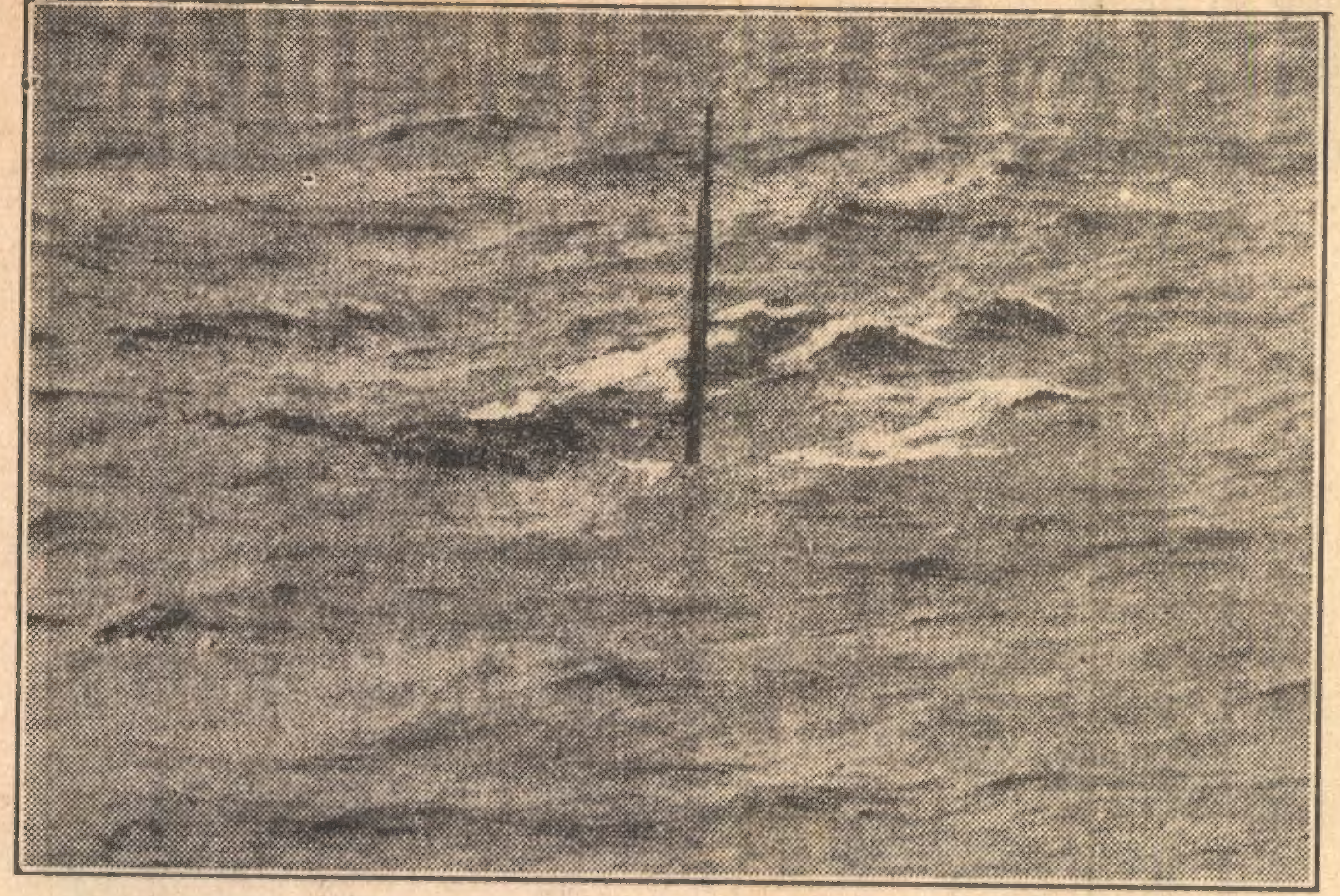


The first power driven heavier-than-air plane ever to fly. It was designed by the Wright brothers and flown at Kittyhawk, North Carolina, in December, 1903. The aeroplane travelled tail first, and flight was controlled by warping the wing surfaces.

A 1912 model Curtiss seaplane. Glenn Curtiss evolved the idea of hinged ailerons to control flight and, after much litigation, was granted a patent on the idea. The court ruled that the Wright brothers had no monopoly on the idea of flying and that Curtiss' scheme of rigid wings and adjustable flaps represented a distinct advance of the original idea of warping the entire wing surface.

FEATURE STORY

No Patent—Thanks To Jules Verne



Beneath this uninteresting stretch of water lies a submarine. The only contact with the outside world is the slender periscope protruding above the surface of the waves. The would-be inventor of the periscope found that he could not patent the idea because Jules Verne had mentioned such a scheme in the novel "Twenty Thousand Leagues Under the Sea."

tailed publicity. If you think you can keep your idea secret, you are at liberty to do so forever without a patent. But if you want to be in a position to defend your rights and prosecute infringers, you must make your secret public.

If you can't "cash-in" within sixteen years, it is assumed, in America, at least, that your invention is no good, or that you are just unlucky. In England and the majority of the Dominions, if the inventor can demonstrate that he has not had sufficient time to properly remunerate himself, the sixteen-year term can be extended, on application to the authorities.

In the United States, if a Patent Office examiner is not satisfied regarding the true novelty, utility or invention of the machine for which a patent is asked, the patent is not granted. The inventor cannot secure a patent if anybody ever made, used or publicly described anything like his invention more than two years before he applied for it.

IDEA MUST BE NOVEL

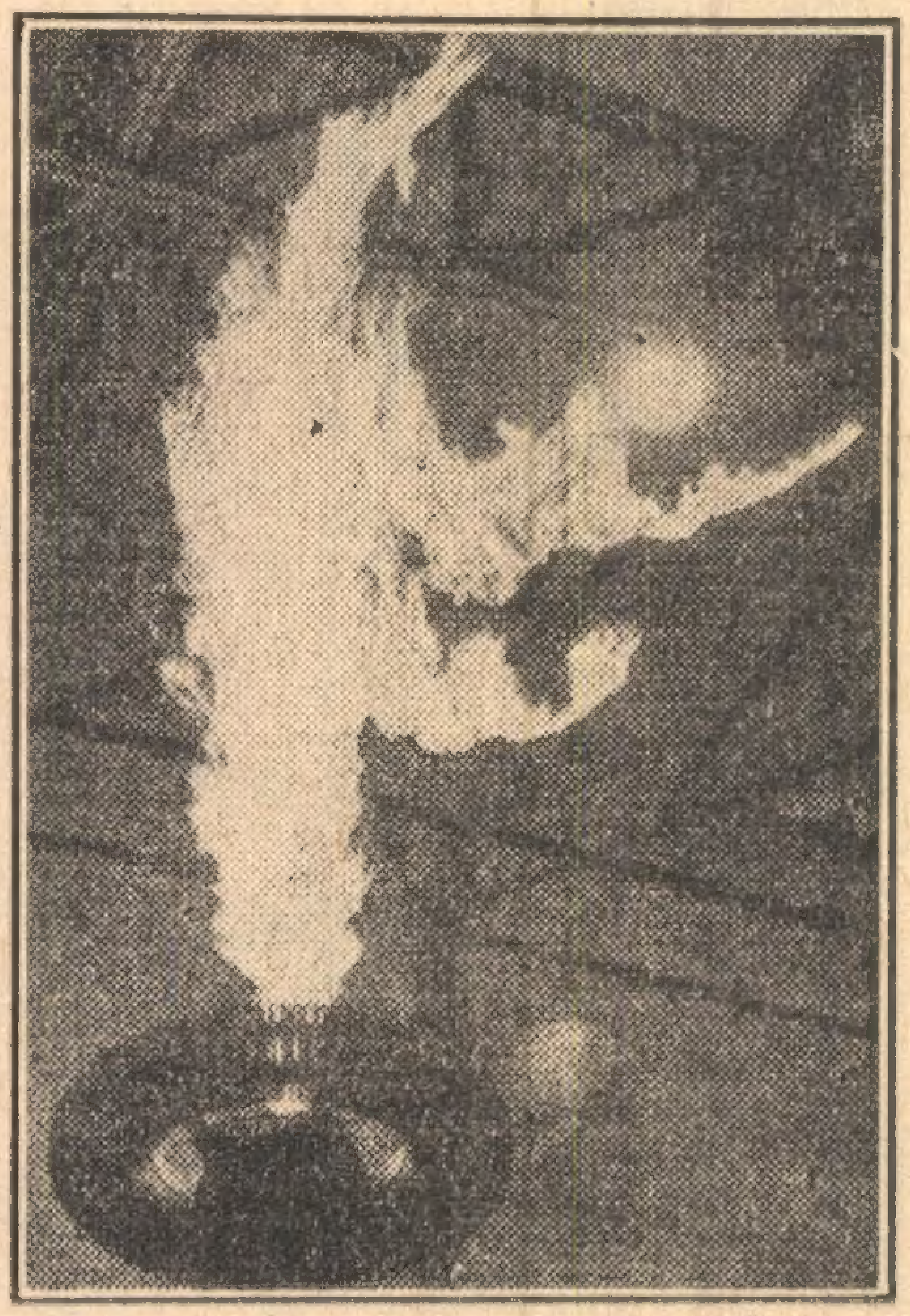
If the examiner finds in print anywhere—in a scientific treatise, a novel or even an imaginative romance—a device described containing the essential elements included in a pending patent application, out it goes. Someday someone may apply for a patent on a spaceship or a death-ray gun, and some of the current "Speed Gordon" comic strips may be brought in to block it!

In the early days of submarines, a writer, Morgan Robertson, was talking to Lewis Nixon, the head of a shipbuilding company that was then building submarines. The trouble with submarines, Nixon remarked, was that they had to come to the surface to see where they were going.

Robertson picked up pencil and paper and drew a rough sketch of a right-angled rotating telescope, to be pushed to the surface from a submerged submarine. Nixon was enthusiastic and offered on the spot to apply for a patent in Robertson's name and pay him a substantial royalty.

JULES VERNE, INVENTOR

When the papers reached the principal examiner in the Patent Office, he had a vague recollection of having read of a similar device. Sure enough, Jules Verne, in his "Twenty Thousand Leagues Under the Sea," had equipped Captain Nemo's Nautilus with a similar revolving spy-glass!



A spectacular experiment with artificial lighting in the laboratories of the California Institute of Technology. The equipment necessary for experiments and research of this nature is normally beyond the means of private individuals.

Since then many patents have been granted on improvements in periscope design, but the basic principle is unpatented and unpatentable because a writer of pseudo-scientific romances first imagined and wrote about it.

In Australia it is regarded as safest to patent your invention as soon as it is worked out. The first patent lodged carries with it the greatest assurances of protection. In the United States, on the other hand, the roughest kind of sketch, so long as it shows the principle of the machine, dated and with the date witnessed by two people, carries with it complete protection for two years.

When the bicycle craze was approaching its height in the 1890's, an Englishman named Smith owned a bicycle repair shop in Washington, DC. He built a few bicycles to his own design, but ill-health forced him to sell his shop, and he died shortly afterwards.

The buyer, a man named Owen, found a number of bicycle patents which Smith had taken out. One of the patents was for a method of housing a bicycle crankshaft, a method then being used by every bicycle manufacturer.

BICYCLE PATENTS

An infringement suit was brought against the largest manufacturer; the rest joined in meeting the expenses and prepared to fight the Smith patent. Witnesses were brought from England who swore that Smith's device had been used there before the date of Smith's patent application. Pinned down to an exact date, the witnesses set a day just short of two years earlier than the Smith application.

Mrs. Smith had been her husband's accountant and business manager. Owen's lawyers started a hunt for the widow, who had disappeared. The only clue to start with was the fact that Smith had died in Buffalo. The registry of vital statistics there provided the address where he had died. It was a boarding-house, whose landlady knew nothing of Mrs. Smith's movements, but remembered that she had remarked, after the funeral, that when her business arrangements were cleared up she intended to enter a convent.

150.000 DOLLARS FOR INFRINGEMENT

Inquiries at the Buffalo diocesan headquarters located Mrs. Smith in a convent in Batavia. She had a trunk full of her husband's papers, and among them, duly signed and witnessed, was a drawing of the disputed invention dated earlier than the earliest date claimed by the English witnesses. Owen collected 150,000 dollars from the bicycle manufacturers for infringement.

You don't need to make a model of your invention. Patent offices used to ask for working models of everything. That practice was abandoned early in this century, and now all you need to submit is a drawing. There is just one exception. You must submit a work-

ing model if your invention is a perpetual motion device!

Up to about the time that the Wright brothers proved that men could fly, the Patent Office not only called for working models of almost everything, but wouldn't even consider an application for a patent on anything so obviously impossible as flying or as perpetual motion.

MODELS AND DRAWINGS

Since mechanical flight became a reality, they will consider your perpetual motion machine if you can show it working. Nobody has shown the Patent Office such a device so far.

An increasing proportion of patents require no drawings. How would you draw a picture of "a product in the form of a solid powder consisting of sodium formaldehyde sulphoxylate combined with a glucoside of 3, 3'—diamino—4, 4'—dihydroxyarsenobenzene, the said powder being a neutral compound and readily soluble in water"? But a patent on that chemical combination was issued recently to a British chemical house.

Perhaps a brake for roller skates may not fill a long-felt want, but an enterprising American has patented one. Of probably wider usefulness is the capped nailhead patented by a Chicagoan, Robert Kaplan. The upper shank of the nail is coated with an adhesive material which softens under the heat generated by friction in driving the nail. The nail stays put when it is driven home.

REMOTE CONTROL BY RADIO

One day in 1913, when wireless telegraphy was still an awesome miracle, the yachtsmen and fisher folk of Gloucester Harbor, Massachusetts, were startled by the appearance of a motorboat running at full speed with nobody in it. The boat seemed to be obeying an unseen helmsman as it wove in and out among other craft and finally returned to shore. The unseen helmsman was John Hays Hammond, jun., who was making his first public demonstration of remote control by wireless.

Mr. Hammond has kept on inventing ever since in applications of radio, mostly in the same field of remote control. He has nearly 700 patents under which it is possible to operate a ship or a boat, an aeroplane or dirigible or a submarine, without a soul on board, to drop a bomb or discharge a torpedo from a distance, or to guide a torpedo to its mark—all by wireless impulses.

The United States Government has first option on the use of all Mr. Hammond's inventions and the Army and the Navy pay him royalties on more than 100 patents. Perhaps Mr. John Q. Public, the American citizen who pays the taxes and incidentally the royalties, will shortly begin to wonder when some of the remote control devices will come into use against the Japanese.

ACCIDENTAL DISCOVERIES

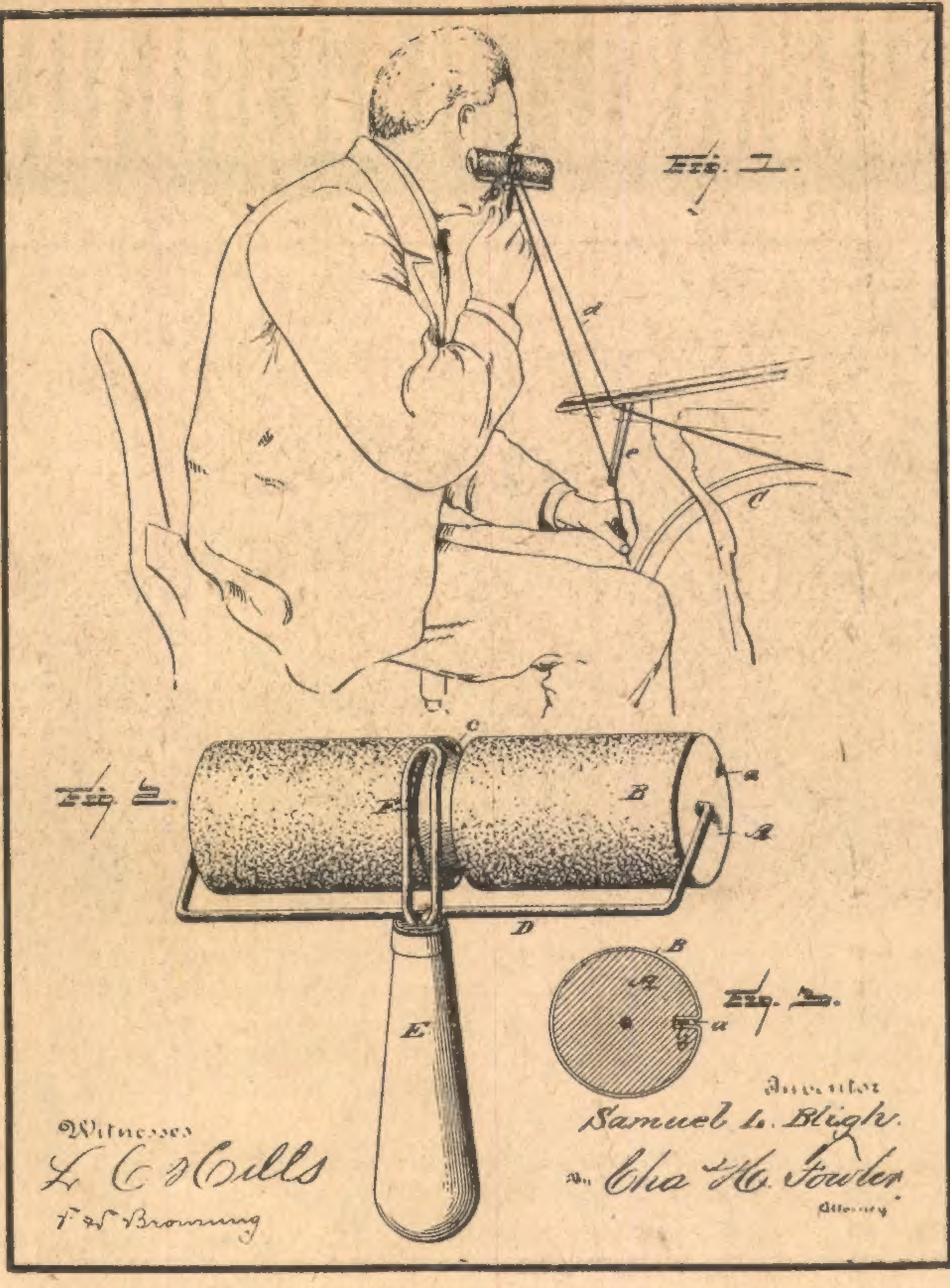
It is part of the natural cussedness of existence that, despite months and sometimes years of hard work, the most amazingly simple inventions have been produced accidentally. When chemists in the Du Pont laboratories were trying to work out cellulose lacquer, they tried one mixture after another without success, until one day they found that their latest batch, which had been left standing during lunch-time in an open container, was precisely what they had been seeking. It had everything.

They mixed another batch and it didn't work. Then someone suggested that perhaps some foreign substance had been dropped into the compound while they were at lunch. They put the mixture through various tests and found traces of what appeared to be casein. But where could casein have come from in the laboratory?

Detective work disclosed that two Italian workmen had picked that corner of the lab. as a good place to eat their lunch. One had tossed a piece of cheese to the other and it had fallen into the lacquer kettle.

Casein was added to the original formula, and the result was the first quick-drying waterproof lacquer, which, among other things, reduced the cost of motor-cars.

THIS INVENTOR WAS A TOUGH MAN



The patent office files contain plenty of so-called "crazy" inventions. As you can see, an inventor was granted a patent for this shaving device. It consisted basically of a wooden drum, covered with sandpaper, which was driven at high speed by a treadle arrangement beneath the table. When held against the face, it was supposed to remove the whiskers. It would probably have a similar effect on the first few layers of skin. Another patent was for a "horseless" carriage propelled by two dogs continually running up the forward slope of a hollow front wheel.

★

THERMOSTATS

The not uncommon incident of an electric iron, left unwatched with the current on, burning a hole in the ironing-board, set working the inventive mind of a young mechanic. From his bench in the factory, John A. Spencer had frequently heard the loud click of the door of the firebox under the steam boiler.

He observed that the click was caused by the buckling of the sheet metal as it got hotter or colder. If a convex sheet of metal could change its shape so abruptly under changes of temperature, why couldn't that principle of thermo-dynamics be applied to making an electric switch which would automatically throw off the current when the iron got too hot?

SIMPLE THINGS

It could; and that thermostat is now incorporated in more than ten million electric irons, besides being used for other heat-control purposes.

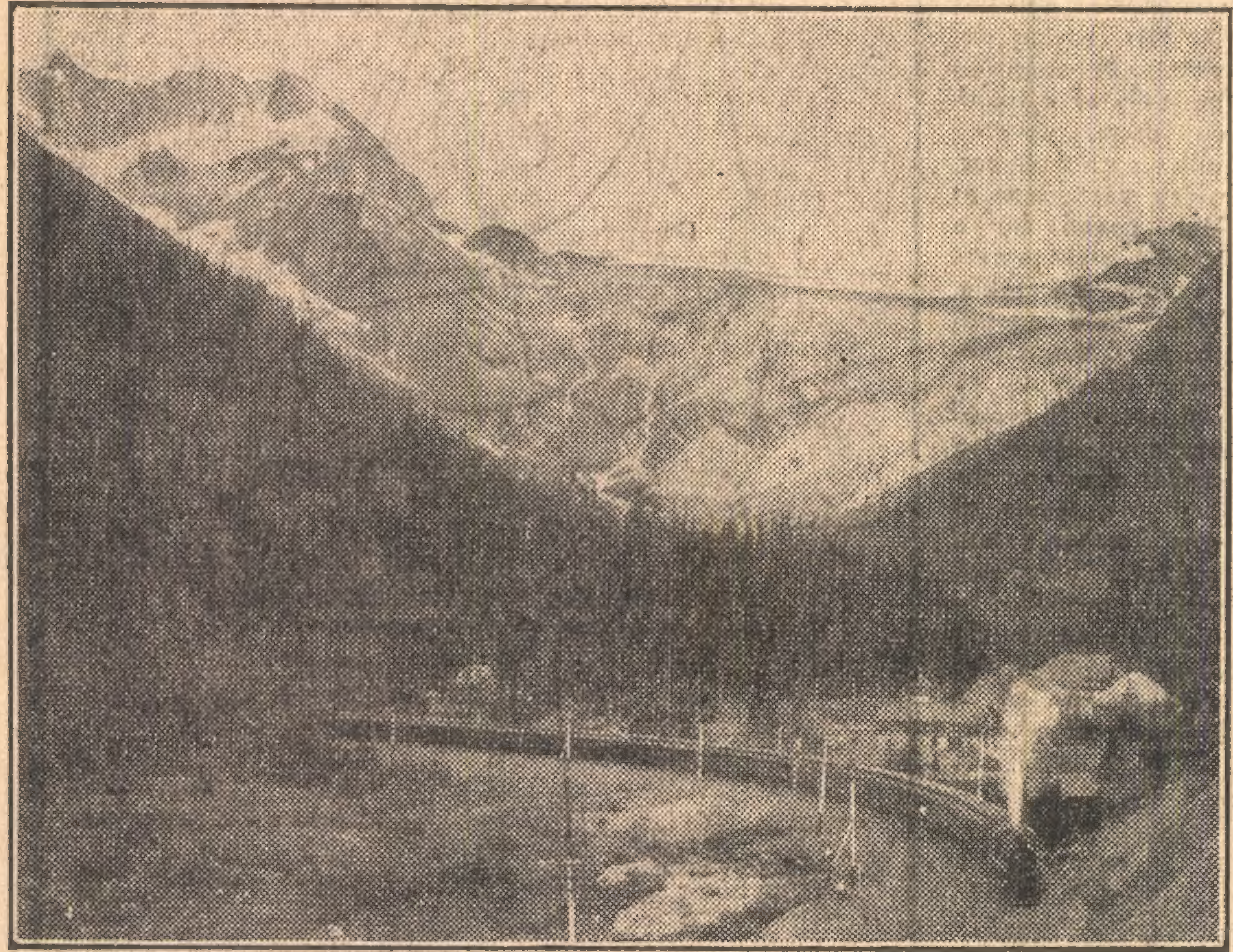
This invention was reported sold for the usual million dollars; whatever the price, it shows what can be done in the way of invention when the would-be inventor keeps his eyes open and his mind at work. Nothing could be simpler than the circular typewriter eraser with a hole in the middle so that it can be tied to the machine and not always be getting lost. That boon to stenographers is reputed to have made a fortune for the inventor.

Your invention does not need to be revolutionary or epoch-making to be worth money to you; very few inventions in recent years have been. Skip the basic inventions, and it would be hard to count more than a dozen in the past fifty years which have revolutionised the world as the telephone and the incandescent electric light have done in the memory of living men.

Perhaps the ten most important inventions to come into commercial use in the past fifty years have been the electric furnace, the steam turbine, the

(Continued on Page 51)

RUNNING RAILROADS UNDER THE EARTH



Scenes like this one in the Canadian Rockies are a delight to tourists and an ideal setting for adventure novels. However, to the railroad engineer, the lofty peaks and deep ravines present problems which can only be overcome by the exercise of all his engineering skill and ingenuity.

Not the least important task in the construction of a railway is the boring of tunnels. There is a fascination that appeals to young and old alike in the great engineering feats that are necessary in order that man may take his railway lines along the shortest distance between two points.

LONG before man had conquered the air, he had conquered the earth. It is characteristic of humanity in general that he allows nothing to stand in his way. Should he wish to travel to the other side of a range of mountain he takes the shortest way—by boring through. If there is no room for trams and trains on the surface of the ground, he goes underneath. Should he wish to cross a river without a bridge or boat, then the only way is to bore underneath the bed of the river.

The romance, danger, and skill displayed in the construction of tunnels passes unnoticed by the multitude of people who ultimately benefit by the enterprise.

When tunnels were first constructed the work entailed was unbelievably more difficult and dangerous than it is today. Great were the disappointments and danger in those days.

The tunnel had to be dug with pick and shovel by the light of candles. Roofs would fall in. Water would burst through and poisonous gases make their appearance. Danger was present at all times.

Today men work in comparative safety in steel shields by the light of electric lamps. Modern machinery such as excavators and drilling machines come to their aid. Geological surveys determine beforehand any likelihood or otherwise of water being encountered, and the type of rock and earth that will be present at any given depth.

Perhaps the oldest tunnel in the world was the one under Monte Salviano, in Italy. This was used for the draining of Lake Fucino, and was three and a half miles in length.

The invention of the steel shield in tunnelling was brought about by an idea of Brunel, who first used the scheme in boring his tunnel under the River Thames.

by Calvin Walters

The Thames tunnel was begun in 1802 by the sinking of a shaft. The actual tunnelling was commenced in 1807 by Trevithick. The total distance tunnelled at this attempt was 1100 feet. The river-bed fell in several times, and the work was finally abandoned after five years.

Brunel, who later took up the work, got his idea of a shield from nature. In 1816 Brunel was in a dockyard and noticed a piece of timber that had been bored by a worm. On examination of the hole in the wood and then the construction of the "animal," as he termed it, he found the worm "armed with a pair of strong, shelly valves, which enveloped its anterior parts."

"With its foot as a fulcrum, a rotary motion was given by powerful muscles to the valves, which, acting on the wood like an auger penetrated gradually but surely. As the particles were removed, they were passed through a longitudinal fissure in the foot which formed a canal to the mouth, and so were engorged. To imitate the action of this animal became Brunel's study." Such were the words of Bunel's biographer.

In 1818 Brunel took out a patent for his cellular boring machine. It consisted of 36 independent cells. By placing the machine against the face of the earth to be tunnelled, 36 men, one to each cell, could hew the face of the soil and throw the soil out the back.

A distance of three feet was excavated from the front of each cell, and the shield was moved forward by hydraulic jacks. The opening of three feet left behind was lined with bricks.

THE SIMPLON TUNNEL

Of course, great improvement has now been made in the shields used for under-water tunnels, but it is to Brunel that credit must be given for the idea.

One of the greatest of all engineering achievements was the construction of the Simplon tunnel through the Alps of Switzerland. This tunnel is 12½ miles long. The construction took from 1898 to 1905, and cost three million pounds. Among the difficulties encountered was terrific underground heat, and flood from hot and cold springs.

The Simplon tunnel was commenced from both ends, and so accurate was the original survey and the construction that, when the tunnel met in the centre, the walls exactly corresponded and the floor levels showed a difference of only four inches.

ALIGNING A TUNNEL

The method of aligning a tunnel is most important, and upon the accuracy depends a great deal of the ultimate cost.

When shafts cannot be sunk along the line of the tunnel the method generally adopted is that which uses transmit instruments.

PROBLEMS TEST SKILL OF ENGINEERS

An observatory is erected at some distance from each end of the tunnel. These are erected on a moun'ain, where practicable, or upon masonry.

The transmit instrument consists of a telescope with hairs crossing the object glass at right angles in the centre. There are also divided circles and a level.

VERSATILE INSTRUMENT

The instrument can be tilted at any angle and any object can be aligned by sighting through the telescope until the crossed hairs come into alignment with the desired object. Thus, a sight can be taken with the axis of the tunnel from both ends. The boring can also be checked as the work proceeds.

If possible, an observatory is also placed on the top of the mountain over the line of the tunnel, and by means of flashing signals the alignment can be kept constant with the observatory at each end of the tunnel.

Of course, allowance must be made for the difference in elevation of the floor at each end. In the case of the Simplon tunnel, the rails at one end were 175 feet lower than at the other end. The fact that the alignment was almost perfect when the tunnel met at the centre speaks volumes for the thoroughness of the surveyors.

BUILDING TUNNELS

Having surveyed the position for the tunnel, having prepared a geological map showing the nature of the earth to be bored, and having considered the probability of encountering water, &c., the actual work of tunnelling is commenced.

It is seldom that large tunnels are driven as one big hole. The cross section is usually divided up into sections and these are worked one at a time. Thus, it is possible for several gangs to work at the same time.

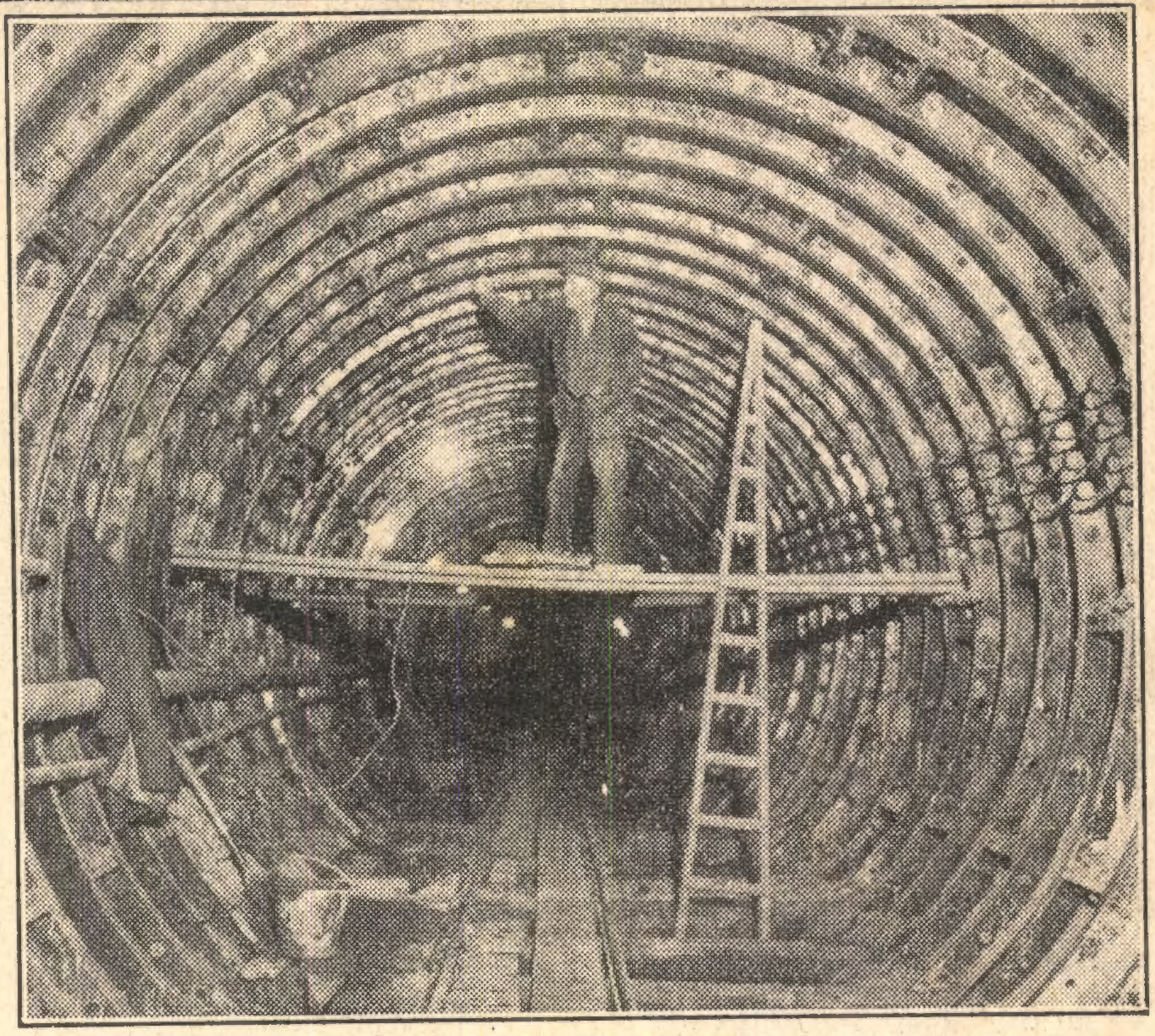
The material is excavated by blasting, where possible, and the debris carried away by a small railway. Incidentally, hard rock is the easiest material to tunnel, as it is easily broken up by blasting and the work does not require so much supporting as in the case with loose earth.

As the work proceeds, the tunnel is lined. Shafts are sunk, where possible, to provide ventilation, and, in cases where this is not practicable, artificial ventilation has to be resorted to.

UNDER-WATER TUNNELS

The work entailed in constructing tunnels for railways is usually fairly straightforward. Notable exceptions were those driven through the European Alps, such as the St. Gothard and the Simplon.

It is in the building of under-water tunnels that much ingenuity must be exercised. The water that seeps through must be got rid of, and, in most cases, mere pumping is not sufficient and compressed air locks have to be brought into use.



For the most part, the London Tube railways are not built in solid rock but are driven through unsubstantial sand and clay. This picture was taken in 1937 during the construction of an extension between Baker-street and Pinchley-road. Note the network of iron rings supporting the sides of the tube. The spaces between the rings will later be filled with concrete.

During the construction of the tunnel under the River Severn, flooding was the most persistent cause of trouble. The first shaft of this tunnel was begun in 1873 and the tunnel was completed by 1881.

WATER CAME THROUGH !

At 45 feet down the first shaft a spring was encountered, which flowed at the rate of 12,000 gallons an hour, while four yards further down another spring was tapped which yielded 27,000 gallons an hour. At 200 feet the men opened up another spring, and a flood of water at the rate of 360,000 gallons per hour filled the works for 355 yards from the shaft.

Great pumps were installed, and a diver went down the shaft and closed water-tight doors one-quarter of a mile away from the entrance. After the works were pumped dry tunnelling was resumed.

While the works were flooded nearly all the water drained from the River Nedern and all the springs and wells in the vicinity went dry. When the water was effectively blocked the river and wells returned to their normal height.

When pumping is not sufficient to keep the workings dry, air locks are used. These consist of a steel cylinder up to 30 feet in length and of a diameter about equal to the diameter of the tunnel.

USE OF AIR LOCKS

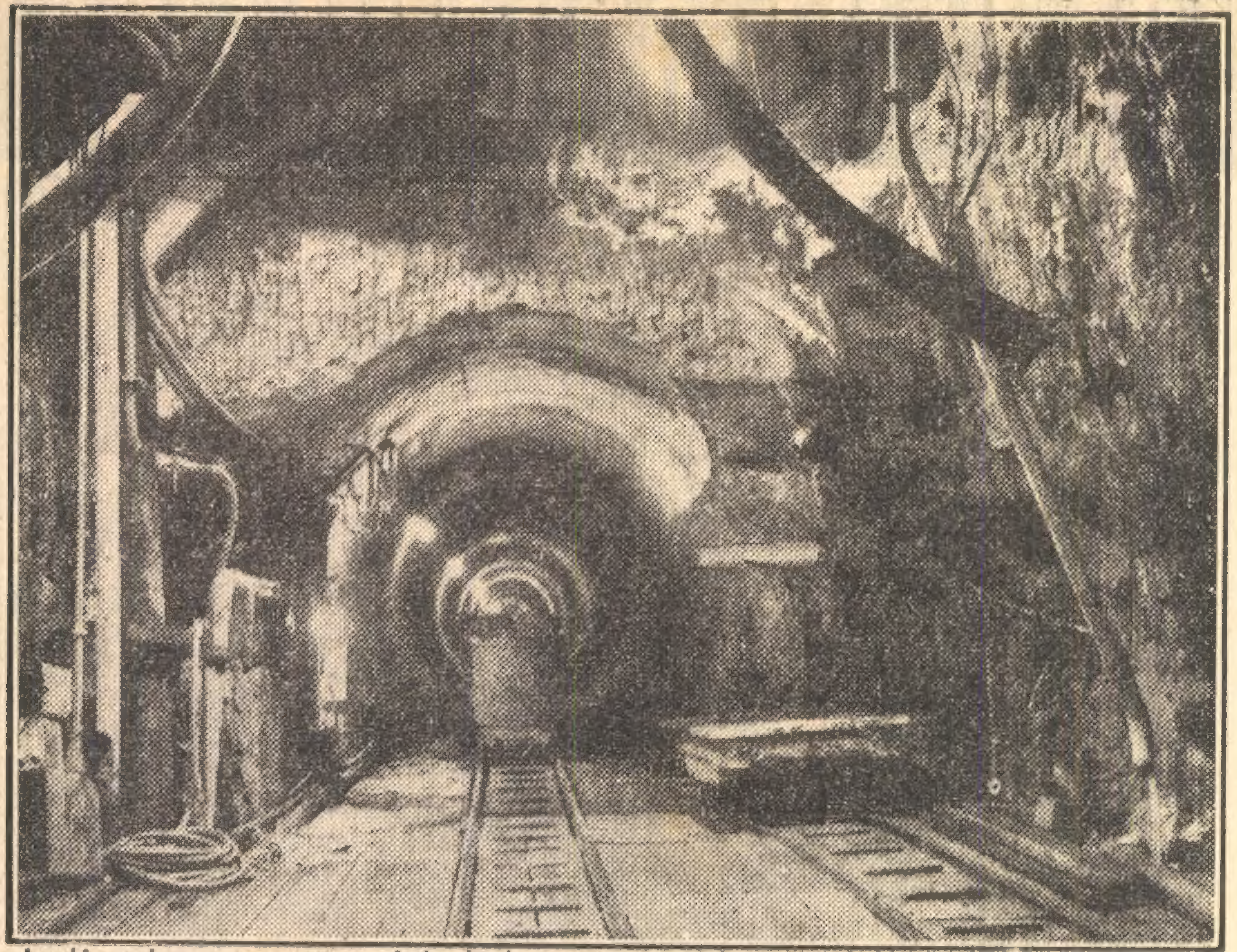
Inside the shield is a vertical bulkhead dividing the shield into several portions. A door is provided in the bulkhead. Inside the forward end of the shield the excavation proceeds. The forward end of the cylinder is a strong cutting edge.

As the soil is dug it is removed out the doors at the rear. The shield is pushed forward by hydraulic jacks as the work proceeds, and the tunnel lining is built inside the rear end of the shield. The shield overlaps the lining by several feet.

When water is encountered, the bulkhead doors are closed and compressed air forced into the forward compartment. This keeps the water from filling the works and at the same time allows the workmen to carry on the excavation inside the shield.

ON Page 66 of this issue you will find a short section devoted to Broadcast Band DX. If you are interested in this subject, we suggest you get in touch with Mr. Roy Hallett, either direct of through the Technical Editor. The success depends on the co-operation of different listeners.

BUILDING A HIGH PRESSURE WATER TUNNEL



Looking along one section of the high pressure tunnel, constructed by the Sydney Water Board to carry water between Potts Hill and Waterloo. The immediate foreground is a shaft providing ventilation and allowing the transport of refuse and material to and from the surface.

Greater depth increases the difficulties of working in compressed air. As the men have to work in pressures up to 35 pounds per square inch above that of the atmosphere, it is necessary for them to spend some time in air locks before entering and after leaving the working chambers, so that their blood vessels will become accustomed to the differences in pressure.

THE LONDON METRO

In the construction of the London Inner Circle, Metro, the engineers, had other difficulties to overcome. Sewers and gas and water mains had to be bypassed. Old houses were a source of anxiety, as these had to be under-pinned to prevent them collapsing. The rail level varies from 9 feet to 65 below the surface.

The Greathead method of tunnelling overcame the difficulties of having to deal with foundations, sewers, gas, and water mains. In 1886 the City and South London subway was begun. Two tunnels were bored under the Thames by the Greathead method.

The Greathead method is the compressed air system mentioned above, but for interested readers I will give it in greater detail.

THE GREATHEAD METHOD

The shield is like a closed box divided into twelve compartments. These compartments enclose the compressed air and are fitted with valves so that the precise pressure of air can be adjusted.

The shield lies horizontally and is pushed along by hydraulic rams. The compressed air exerts a total pressure of some 200 tons on the face of the soil. The loose material is removed by trucks from the rear. As the shield is pushed along, the sides of the bore are covered with liquid cement and an iron lining ring inserted and built in. Thus, the earth, no matter how loose, is prevented from falling in.

The Greathead method simply cuts a circular hole in the clay, which is immediately lined with an impervious layer of concrete and iron.

The trains fit the tubes so closely that they act somewhat like pistons and induce strong currents in the lift-wells throughout the station system and thus create sufficient ventilation.

One of the most difficult mountain tunnels ever constructed and one which taxed the ingenuity of engineers to the utmost was the St. Gothard tunnel, in the Swiss Alps, which was mentioned earlier. This tunnel is over nine miles long; took eight years to build, from 1872 to 1880.

PROBLEMS OF THE ST. GOTHARD TUNNEL

The northern end of the tunnel was drilled through 6000 feet of granite without encountering any great difficulty, but on the southern end 4000 gallons of water per minute came from the ground. Owing to the slope of the ground, this stream developed into a torrent 20 inches deep in which the drilling machines had to work.

Water poured from the roof, and jets would suddenly come from the walls and knock the workmen over.

The difficulties were added to by the high temperatures encountered in the workings. This reached a temperature of 93 degrees when the headings met in the centre.

A greater difficulty was sudden inrushes of hot water from springs which would scald the workmen. The water was carried off, but work became impossible under these conditions because the hot water raised the temperature of the workings to a still higher degree. Cold water had then to be pumped in to lower the temperature before work could be resumed.

The ventilation of the workings proved insufficient, and many men were suffocated owing to the poisonous gases generated by the dynamite during blasting operations.

NO ARTIFICIAL VENTILATION USED

Contrary to expectations, no artificial ventilation is employed in the completed tunnel. A current of air is set up by the difference in the barometric pressure between opposite ends.

In one part of the St. Gothard tunnel the floor and roof sink over a distance of 100 yards. The workings had to be enlarged at this point and the tunnel lined with granite masonry.

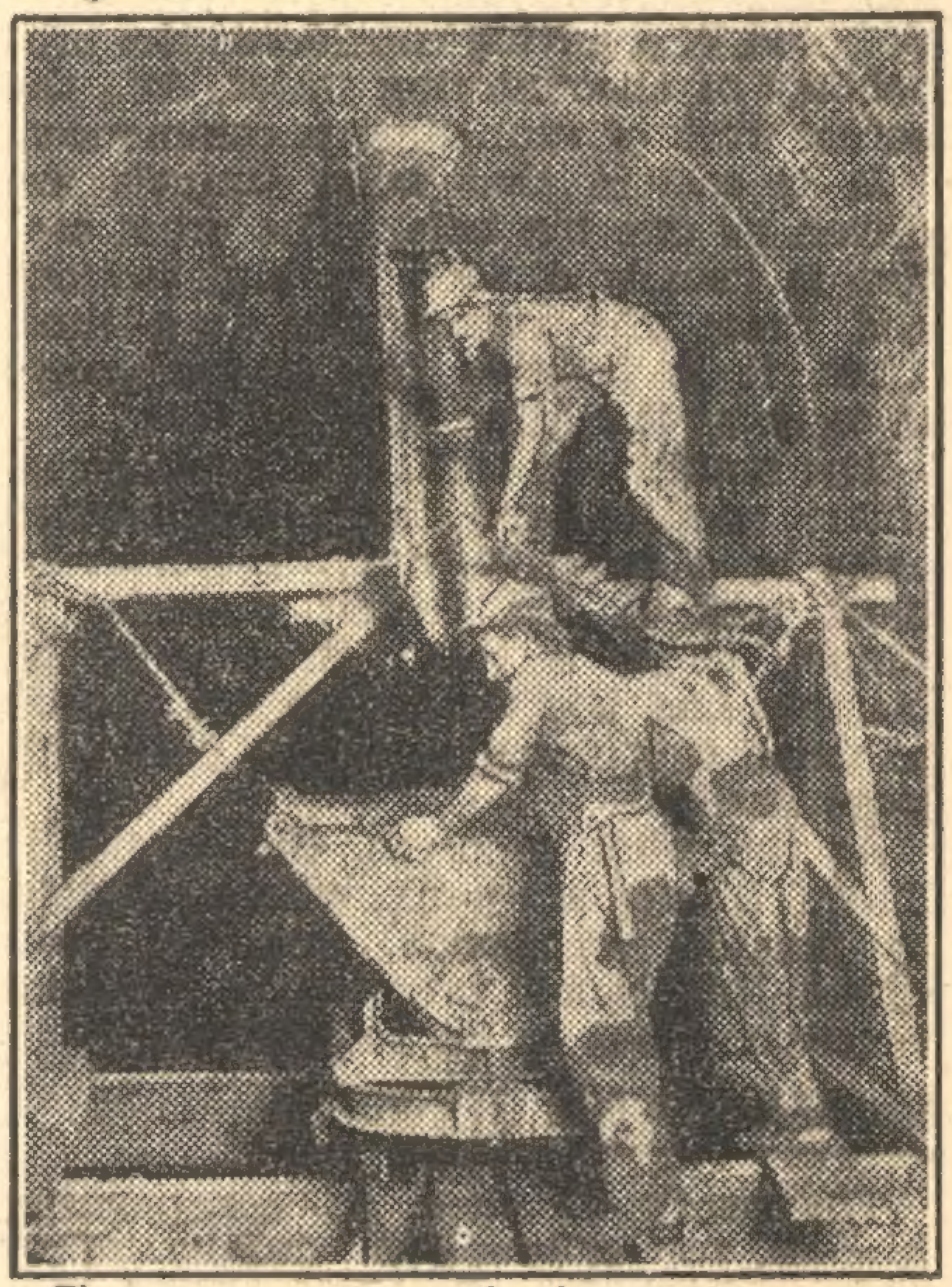
The total death-roll was enormous. Eight hundred lost their lives during operations. Various chest complaints, anaemia, and other internal disorders became prevalent. In the first three months of construction ninety men had to be dismissed through anaemia alone.

Such is man's stubborn nature that the work went on to completion.

The construction of the Simplon tunnel through the Alps did not meet with the same difficulties as did the St Gothard tunnel project. This was largely due to the lessons learned in the construction of this latter tunnel.

UNUSUAL TUNNEL

An unusual type of tunnel 2½ miles long was constructed under the Detroit



The construction of the underground railway in Sydney, Australia, was simplified by the fact that much of it had to be driven through solid rock. The sides of the tunnel do not tend to cave in and a substantial lining of bricks is quite sufficient. Furthermore, buildings above were not endangered. During the construction of the London Tubes, many buildings had to be specially underpinned to prevent them collapsing.

River in Canada. This tunnel joins Detroit with Windsor.

Steel tubes (the actual tunnel) were built up on the surface and sunk into the river, finally settling into a trench dug in the stiff clay on the bed of the river.

The trench was dug out by a dredge and was made deep enough and wide enough to take the tubes resting on piles driven into the bottom of the trench The tubes were 23 feet odd in bore and 262 feet long.

The ends of the tubes were sealed and they were then floated into the water. Cylinders filled with air were attached to the tubes. When the tubes were over the trench the air was let out of the air cylinders and the tubes gradually sank.

Divers fitted the ends of the tubes together and jointed the ends with cement. The water was afterwards pumped out of the tubes and they were lined with cement and the rail tracks laid.

BLASTING TUNNELS

As mentioned above, most above-surface tunnels are dug or blasted out of the mountain. It is only in subaqueous tunnels that the shield is used. All the Alpine tunnels were excavated by making adjacent borings with rock drills and then blasting out the rock with dynamite.

The Mount Cenis tunnel, the first that was built through the Alps, was also the first in which this method was employed. The drills were driven by compressed air just as the case today. This tunnel was opened in 1871, and is 7½ miles long.

In the St. Gothard tunnel it took an average of one year to tunnel one mile, working day and night. 4000 men were employed.

Water power obtained at each end of the tunnel drove turbines which worked the air compressors. Approximately 1500 horsepower was derived at each end of the tunnel in this manner which drove 23 air compressors at each end.

THE MOSCOW METRO

The Moscow Metro is an example of ingenuity which reads like a romance. This underground tunnel was built through slush and sand. In parts of this 45-mile length of underground the sand kept falling in. Liquid cement was poured into and mixed with the sand

When the mixture had solidified it was blasted out in solid lumps and used for building purposes. In other places, where water was troublesome, the ground was frozen and cut out in blocks, the space being filled in with the required tubes before the ground thawed.

Of course, the steel shield was used also to a great extent.

This Moscow Metro is one of the wonders of the world as far as underground railways are concerned. Huge station platforms are constructed of solid marble, a different colored marble for each station.

Indeed, it seems that man can rise to any occasion and can always prove the old adage, "Where there's a will there's a way."

One of the notable features of Moscow is the sumptuous architecture of its underground railway system. Marble of many varieties, special steels and even precious stones were used in the decorative schemes of the stations. Shown here is one of the platforms of the Mayakovsky Square station. Note the fluted stainless steel columns in the foreground and the lighting fixtures above the train.

MORE ABOUT INCENDIARY BOMBS

The following useful hints were given recently by the NES Minister (Mr. Heffron) in regard to the fire bombs used by the enemy and particularly by the Japanese.

Magnesium, thermite, phosphorus, oil and sodium are some of the materials used in fire bombs.

In air-raids on Britain the Germans mostly used magnesium-thermite and oil bombs. These caused great destruction.

The Japanese are using a different type of fire-bomb. With other types, they are dropping a combination high-explosive and fire bomb.

It weighs 110lb., has a light metal case, and contains several hundred cork and rubber pellets impregnated with phosphorus.

The bomb explodes on impact and the pellets are hurled in every direction for about 50 yards.

Some of these pellets ignite immediately, some burst into flame after a few minutes, and others lie dormant for several hours.

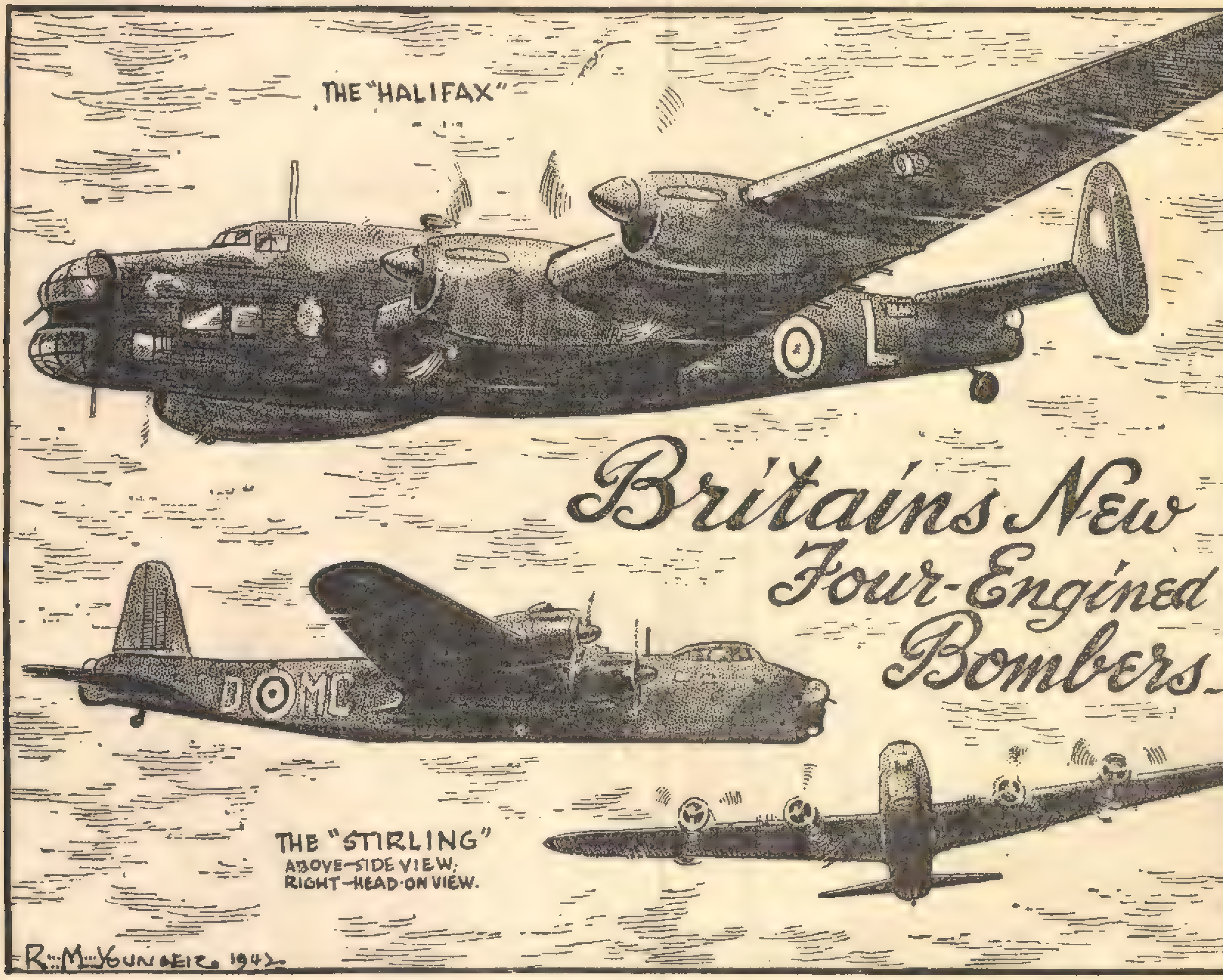
The incendiary action of these pellets is not so violent as the action of the magnesium-thermite bomb. The greatest danger is the multiplicity of pellets.

When these phosphorus impregnated pellets burn, clouds of smoke are given off. This causes smarting of the eyes and throat. The smoke is not poisonous once it has mixed with air.

The best way to deal with these pellets is to cover them immediately with sand or to pick them up on a metal shovel and drop them into a bucket of sand. Water projected on the pellets will temporarily extinguish them, but they will burn again when dry.

Do not allow the phosphorus to touch your skin, as phosphorus burns are extremely painful and take a very long time to heal.

THESE PLANES WILL HARASS GERMANY



When the war began two-and-a-half years ago, and during its early stages, Britain had no four-engined land-based bombers. The Bomber Command placed its faith in "medium" (two-engined) types, and long-range single-engined bombers.

by R. M. Younger

NOW that the war has spread over such vast areas, and particularly since British bombers have had to fly great distances over enemy-occupied territory to strike the Germans where we want to strike them—in Germany—the need for really heavy bombers has increased.

British aircraft manufacturers are answering the call with outstanding planes, notably the Halifax and the Stirling types, which are sketched above.

The need for really big bombers is very great. The advantages of using a few big bombs instead of many small ones is perhaps the most important lesson about aerial bombing, which has so far been learned, and it places a particular premium, not merely on carrying bigger bombs in the racks, but on the plane that can lift the biggest load into the air.

The whole point of the bombing lessons of the war is that medium bombers are not decisive factors; it is the "heavies" that count. It has been officially announced recently that Britain was now concentrating on the heavy bomber.

Sketched at the top is the Halifax. This aerial monster, having a span of 99ft. and a length of 70ft., is not unlike America's Consolidated Liberator bomber, but its performance is better. It is a mid-wing monoplane with retractable under-carriage.

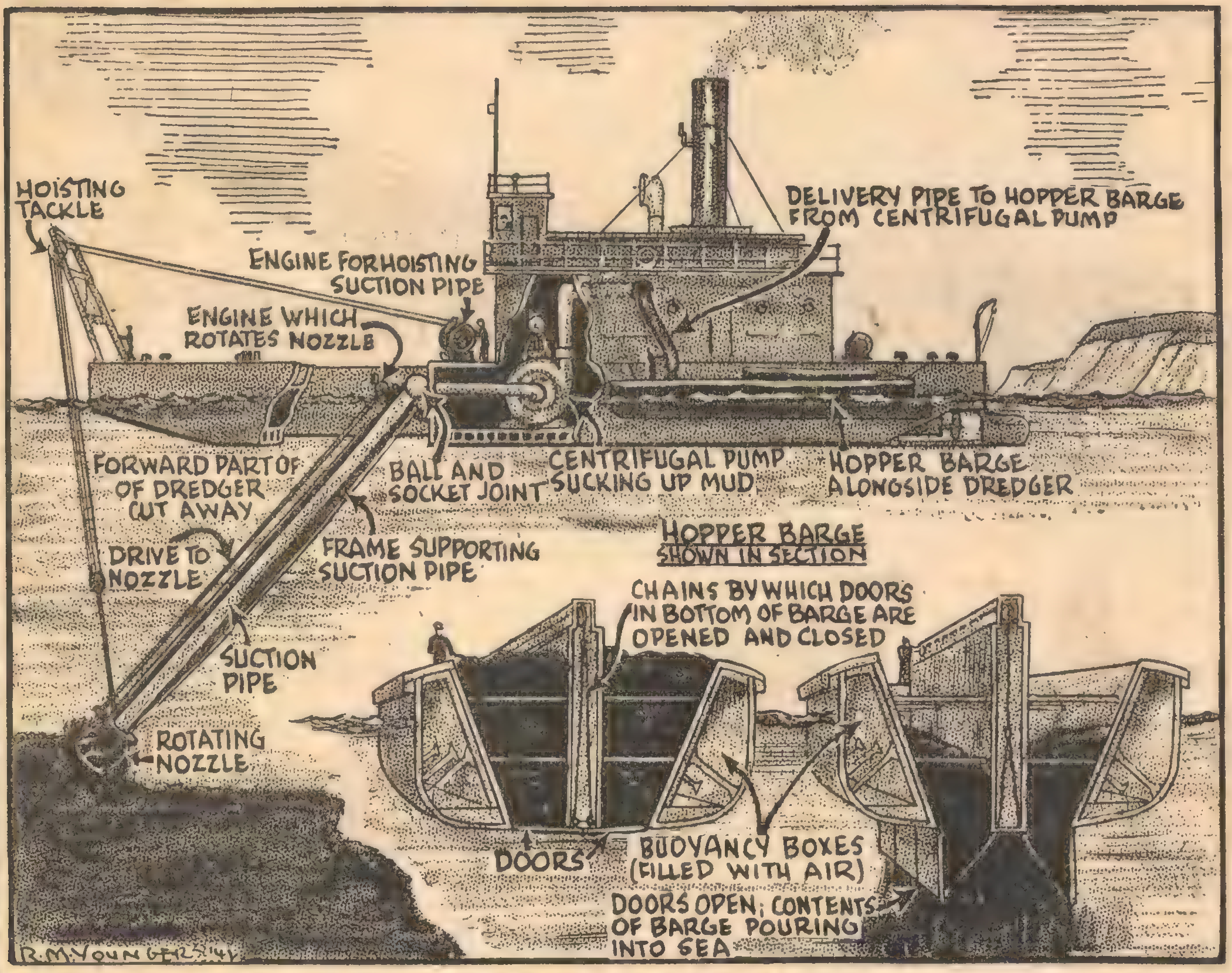
The bomb-aimer's position is in the base of the nose. Above it is the front power-driven turret, from which the guns have wide-angle fire. The pilot's cabin is still higher and further back. There is a rear-gunner's position in the tail, behind the elevators and big twin fins.

THE SHORT STIRLING

Another of the new British bombers designed to combine enormous bomb-carrying capacity with tremendous speed is the Stirling, two views of which are shown in the lower part of the

(Continued on Page 61)

"HOW IT WORKS"—BY R. M. YOUNGER



THE SUCTION DREDGER

Dredges are among those many "far from beautiful" contraptions which do very useful jobs. Stately ships can only enter many ports and rivers because an ugly dredge is kept constantly at work.

THE particular type of dredge known as the suction dredger, is exceedingly valuable for use at port entrances, in harbors and in canals, where shifting sand and mud banks are a problem. It cannot be used where there are boulders or rocks.

As its name implies, the suction dredger sucks up the material to the surface, through an air-tight pipe, which is supported by a hinged frame. The end of the pipe is lowered by hoist machinery to the bed of the harbor or river. A circular rotating nozzle, driven by a small engine aboard the dredger, churns up the mud and sand on the bed.

The other end of the suction pipe leads to the centre of a very powerful centrifugal pump in the dredger. In this pump, a fan or impeller revolves at high speed, and its action forces the contents of the pump outwards from the centre through an outlet at the circumference, causing a partial vacuum at the centre of the fan.

Water is thus sucked up the pipe to fill the vacuum, being forced up by the air pressure and the water pressure at the harbor or river bed.

Mud and sand are brought up with the water, and discharged by means of a pipe from the pump outlet into a hopper barge, which is moored alongside. A constant stream of dredged material passes from the bottom of the river, canal, or harbor, and is poured out through the discharge pipe.

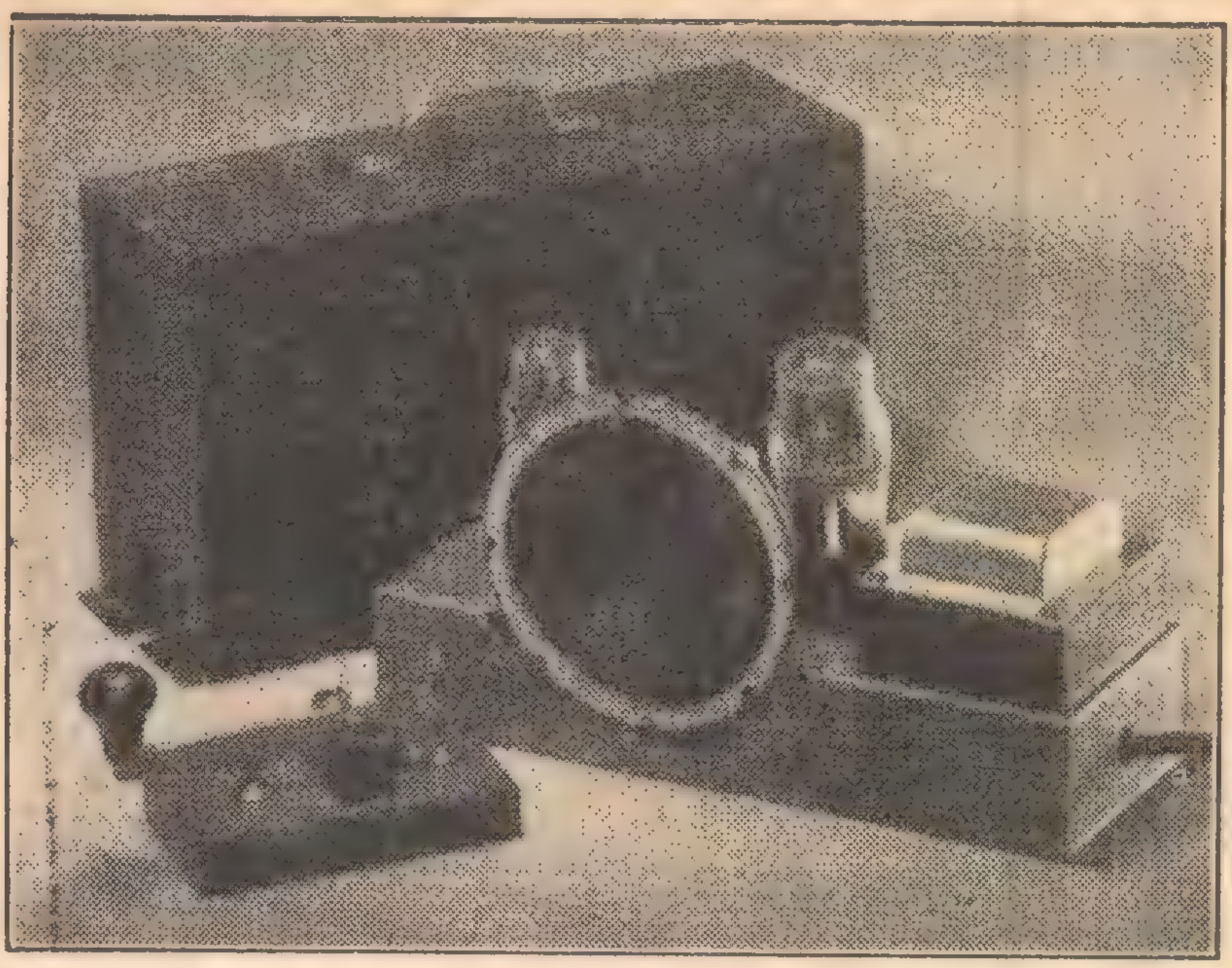
When filled, the barge is towed out to sea and its contents dumped.

THE HOPPER BARGE

A hopper barge is shown in section in the lower right-hand corner of the sketch. You will see that the barge has doors in the bottom, which open so that the contents can be discharged without trouble. Buoyancy boxes running along the sides of the barge keep it afloat at all times.

The suction dredger is used extensively for gold dredging as it provides an enormous flow of material which is essential for success in winning gold in payable quantities from river-beds.

AN A-C OPERATED AUDIO OSCILLATOR



The experimental audio oscillator. The chassis on which it was built and the steel case were originally designed to house the power supply for an AC/battery portable receiver. However, as you can see, they came in very nicely for the oscillator, after a little manual work.

Ever since the outbreak of hostilities, our readers have displayed quite a lot of interest in morse code oscillators. Ample evidence of this comes to light in our mail. Day after day enquiries come to hand from enthusiasts anxious to build up small audio oscillators and to learn the morse code.

by

S. T. Clark

MANY want nothing more than the simplest possible circuit, capable of operating one or two pairs of headphones and obviously intended for purely private and individual use.

However, under one name or another, a surprisingly large number of Morse classes are being organised, and there is, consequently, a consistent demand for more powerful oscillators capable of operating a small loud-speaker or several pairs of headphones at the one time.

A suitable circuit can be evolved. easily enough, using one valve as an audio oscillator and a second as an amplifier. In fact, the majority of large oscillators at present in use probably use this principle.

A SIMPLE CIRCUIT

However, it is one of the characteristics of the human species that they are always on the lookout for an easier way of doing any particular job. Perhaps one should also include the adjective "cheaper" in the above statement.

Well, then, we cannot imagine an audio oscillator much simpler or much cheaper to build than the one which has been developed by our contributor Mr. S. T. Clark.

HARTLEY OSCILLATOR

The circuit itself is unique, and, as far as we know, it is new to Australian enthusiasts. Despite its simplicity, it performs in grand style. The note is absolutely clean, and there is ample output for a class of a dozen or more. In fact, in any ordinary quiet location, the output would serve a class comprising many times that number.

A glance at the circuit diagram shows that the oscillator employs the well-known Hartley circuit. A push-pull loud-speaker transformer constitutes the necessary centre-tapped inductance. The speaker transformer is connected between the plate and the grid of the valve, the grid being isolated by the .005-mf. condenser (C3). The plate voltage is applied to the centre-tap of the loud-speaker transformer and the grid is returned to earth through a 0.1-meg. resistor. Some initial grid bias is provided by means of a 5000-ohm resistor, connected in the cathode circuit of the valve.

This circuit has already been used in a number of audio oscillators which the writer has seen described, but the unusual feature of the circuit is the method of taking the output directly from the voice-coil winding of the transformer. As far as is known, this scheme is new to Australian enthusiasts.

LOUD SPEAKER & TRANSFORMER

A Rola 5-4 speaker with a full-sized "isocore" transformer was used in the experimental oscillator. The particular transformer was intended to present a plate-to-plate impedance of 10,000 ohms.

However, other types of transformers could be used provided that they are centre-tapped. It may be found that the values of the various resistors and condensers may have to be varied a little to obtain a suitable note.

This is quite the usual thing with audio oscillators of any description and is no great hardship. In fact, most enthusiasts prefer to experiment with such circuits, if for no other reason than to see what happens when different values of components are substituted.

VARYING THE NOTE

If the note is too low, decreasing the values of C3 and R4 will usually raise it. If the note is too high, increasing the values of one or both of these components may have the desired effect.

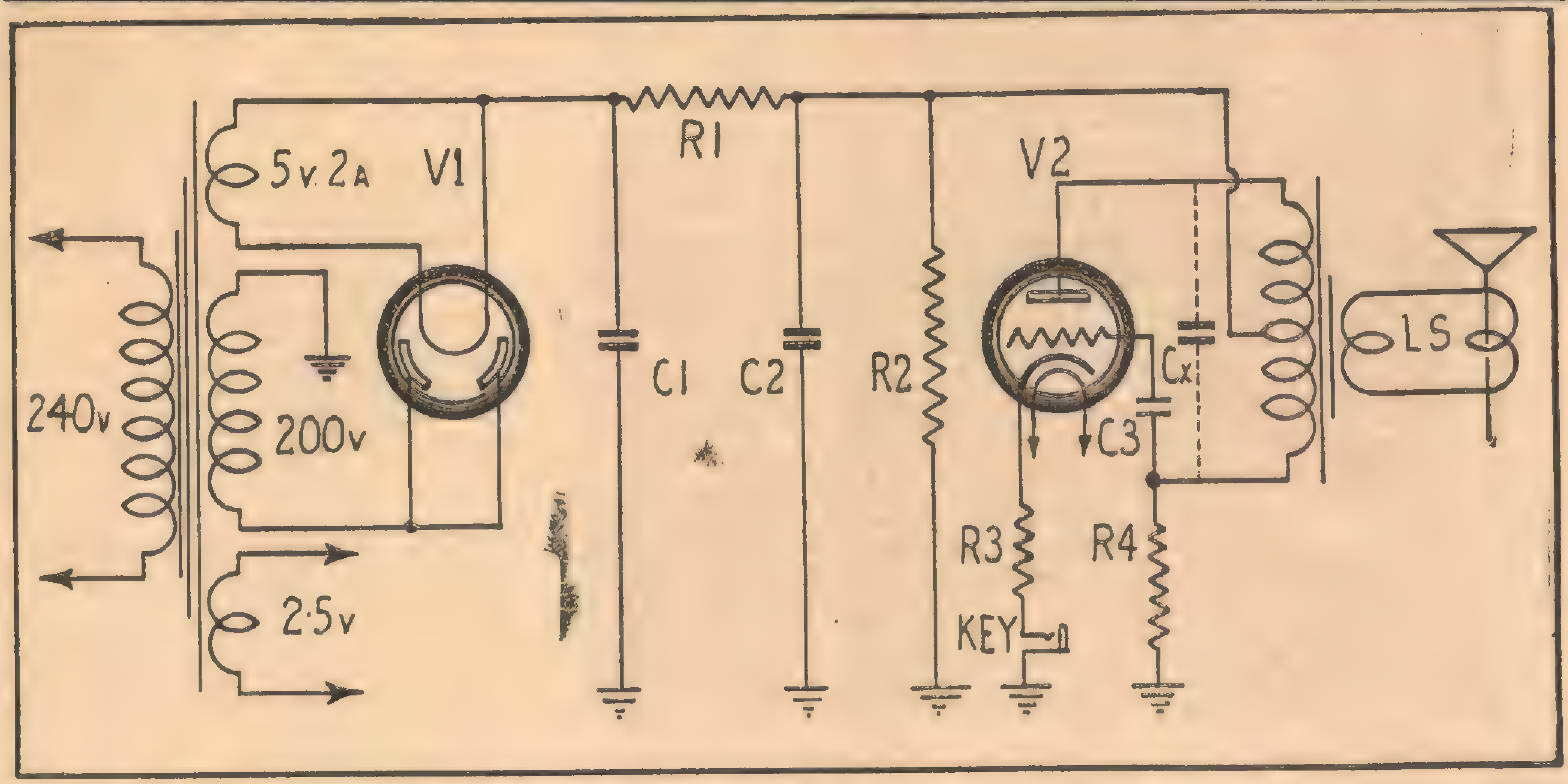
Another method of lowering the pitch of the note is to connect a condenser across the transformer winding, in the position shown as condenser Cx. The most suitable valve can be found by experiment.

If it is desired to have a means of varying the note at will, the resistor R4 may be made variable. For this purpose a 0.5-megohm potentiometer may be used in the position, the inner terminal going to grid and one of the outer terminals to earth. Both outer terminals should be tried and the one used which allows the smoothest variation in the tone.

The valve used in the original oscillator was the general-purpose triode-type 56. Type 27 can be plugged into the same socket without any change whatever.

However, almost any other type of triode could be used satisfactorily. Al-

JUST THE THING FOR MORSE CLASSES



Here is the most important item, namely the circuit diagram. On the left is the power supply, which can be built up as shown or modified, according to instruction in the text, to utilise other standard components. The oscillator employs a conventional Hartley circuit but the interesting point is the method of obtaining the output from the voice coil winding of the transformer. The values of the various components are given in the parts list, but they may have to be varied somewhat to obtain a satisfactory note.

ternatively, an ordinary r-f pentode, connected as a triode, will serve the purpose quite well. Of course, it will be necessary to provide the correct socket and connections and, in certain cases, to modify slightly the various circuit constants until a suitable note is obtained.

It will also be necessary to watch the heater voltages. The particular transformer used in the original oscillator had a 2.5-volt winding, and the valve chosen was one with a 2.5-volt heater.

A FEW EXAMPLES

To mention a few triodes, there are types 56, 27, 53, 55 and 2A6, with 2.5-volt heaters. With 6.3-volt heaters, there are the 76, 85, 75, 6A6, 6N7-G, 6B6-G, 6C5, 6F8, and 6J5. In addition, there are a host of r-f pentodes, such as the 57, 58, 6C6, 6D6, 6U7-G, 77, 78, 6J7-G, 6SJ7, 6SK7, &c. It would be quite out of the question to list component values for all these valves in combination with all the loud-speaker transformers which are likely to be used.

It becomes a matter for each individual to experiment and find the most suitable circuit constants for the particular parts on hand.

Fortunately, there is not much danger of damaging anything when experimenting. For the correct socket connections for the valves, consult a valve data chart.

The scheme can be applied equally well to a-c or battery-operated oscillators. All the experimenting was done with a-c equipment, but it should not be a difficult matter to evolve a suitable battery-operated circuit should such be required.

One possible difficulty in regard to a battery operated version of the circuit might be in regard to the supply voltage, which would need to be fairly high if satisfactory output is to be obtained.

It would also be advisable to use a battery valve with a fairly high transconductance. An output triode or a triode-connected output pentode should meet this requirement.

POWER SUPPLY

At the moment, most of the oscillators of this type will be required at large centres of population, where an a-c supply is usually to hand. Apart from this, batteries are very scarce at the moment. The a-c version is no more costly to build, and is recommended wherever it is possible to use it.

In the original oscillator, the most convenient units were used, although almost any ordinary power transformer and rectifier can be pressed into service.

The small power transformer used was originally designed for use in a power-pack for a battery portable receiver. The primary will operate from voltages of 220, 240, or 260 a-c at 50 cycles. Secondaries are 200 volts 150 mA. 2.5 volts at 1 amp and 5 volts at 2 amps for the rectifier.

(Continued on Page 44)

PARTS LIST

THE following list of parts is given for the benefit of those who may be able to duplicate exactly the original oscillator. However, we realise that, witn this type of circuit, there will be many who will want to build it up, using other standard parts. Various suggestions are made in this regard in the text and the list of parts will have to be modified accordingly. Furthermore, in order to obtain a satisfactory tone, the values of an odd resistor or condenser may have to be varied somewhat.

- 1 Chassis $11\frac{1}{8}$ x $3\frac{3}{4}$ x 2.
- 1 Steel case $11\frac{3}{4}$ x 4 x $6\frac{1}{2}$.
- 1 Steel base plate $1\frac{1}{8}$ x $3\frac{3}{4}$.
- 1 Power transformer, 200 volts HT, 2.5 v. at 1.0 amp., 5.0 v. at 2.0 amp.
- C1 and C2 8mf. 525 volt dry electrolytic condensers.
- C3 .005 mf. mica condenser..
- R1 5000 ohm. resistor, 1 watt.
- R2 50,000 ohm. resistor, 2 watt.
- R3 5000 ohm. resistor, 1 watt.
- R4 0.1 meg. resistor, ½ watt.
- SPEAKER: Five-inch permagnetic type, with suitable push-pull transformer.
- VALVES: Type 80 (or 5Y3-G) and type 56 or other suitable triode.
- Valve Sockets: To suit the valves chosen.
- Sundries: I single-circuit jack, hook-up wire, nuts, bolts and power flex.

WORK OUT YOUR OWN MATHS PROBLEMS

Whilst it is not absolutely necessary for the average home constructor to understand complicated mathematical terms to successfully build a receiver, there is a certain satisfaction in being able to make any calculation as required. No doubt many of our readers already understand the applications of ordinary formulae, as applied to radio circuits but we feel sure there are just as many who are confused and perhaps bewildered by the mention of even the simplest problem.

by C. E. Birchmeier

WHY this should be the case is difficult to say since all the essential formulae for the majority of needs can usually be reduced to very simple and understandable forms. Certainly, some may argue that one can go a long way in radio without recourse to mathematics, &c, and on this point we agree.

However, it is usually found that sooner or later the need for certain calculations arises, requiring a knowledge of certain fundamental laws, and unless these are known, much of the value to be derived from radio work is lost.

Whilst it is impossible in the space available to thoroughly treat all aspects of this subject, it is the aim of this and the following articles to present the most essential and frequently occurring radio laws in a simple, concise form, so that they will be intelligible to the majority of readers. Once these are thoroughly understood, then you should be able to overcome the majority of mathematical problems encountered in ordinary radio work.

SOME BASIC IDEAS

Before going any further, it may be wise to review some basic conceptions of electron flow and movement. Whilst the flow of current through a conductor may appear rather puzzling, possibly due to the action being invisible, it is possible to form a good idea of what really takes place when current flows from one point to the other.

As most readers probably know, all matter, irrespective of whether it is solid, liquid or gas, is made up of small particles called "molecules." Scientists define a molecule as the smallest possible particle of any given substance which can exist alone.

The molecules themselves are made up of a number of atoms, the number and type of the constituent atoms determining the nature of the molecule.

ELECTRON THEORY

By way of example, a molecule of water is made up of two atoms of hydrogen in combination with one atom of oxygen.

Now, in accordance with the electron theory, atoms are not tiny solids, as one might imagine, but are composed of positive and negative electrical charges. The positive charges are called "protons" and the negative charges are called "electrons."

All the protons, or positive charges, are contained in a centre nucleus, usually together with a number of electrons and, under normal conditions, this nucleus never undergoes any change. The balance of electrons revolve around the nucleus in a series of orbits, much in the same manner as a miniature planetary system.

INSULATORS. CONDUCTORS

The revolving electrons determine whether a substance is to be conductor or insulator. In some elements, notably metals, it appears that the atom does not hold all its rotating electrons in rigid control, and some of the outer electrons are free to move around at will. If an electric potential is applied to the material, these free electrons can be made to move in a definite direction. Such a movement of electrons constitutes an electric current.

Materials, in which a movement of electrons can easily be initiated, are referred to as "good conductors." Other materials are poor conductors.

In still other substances, the application of the electric potential may not affect the normal electron movement to any noticeable degree, and hence there is no current flow. Such a substance is classed as an "insulator."

Now that we have some idea of current flow, we will review the three important units to be found in practically every electrical circuit, namely, the volt, ampere and ohm.

FUNDAMENTAL UNITS

The volt, usually designated by the letter E, is the unit of electric pressure. It is also often referred to as the electro-motive force or potential difference, abbreviated to E.M.F., e.m.f., and p.d. respectively. The volt may be defined as the pressure required to send a current of one ampere through a circuit having a resistance of one ohm.

Frequently it is more convenient to use larger or smaller units than the volt. Thus we have the kilovolt equal to 1000 volts, the millivolt equal to 1/1000th of a volt, and the microvolt, equal to 1/1,000,000th of a volt.

The practical unit for measuring the flow of current is the ampere, usually represented by the letter I. It should be understood that amperes do not measure the quantity of electricity or speed, but only indicate the volume of current flowing past a given point in the circuit at any instant.

UNITS OF CURRENT

Technically, the ampere is defined as the value of current that flows through a circuit, whose resistance is one ohm, when the E.M.F. is one volt.

There are two smaller units of current, namely, the milliampere and the microampere. The milliampere is 1/1000 part of an ampere, in other words, one ampere equals 1000 m.a. The microampere is 1/1,000,000 part of an ampere, or conversely 1,000,000 microamperes equal one ampere.

The commonly used unit of resistance or opposition to current flow is the ohm, and this is usually represented in equations by the letter R. As with the volt and ampere, there is a definition for the ohm: An ohm is said to be that resistance possessed by a circuit which will

UNIT CONVERSION TABLES

To convert:

milliamperes to amperes	divide by 1000
microamperes to amperes	divide by 1,000,000
millivolts to volts	divide by 1000
microvolts to volts	divide by 1,000,000
ohms to megohms	divide by 1,000,000
megohms to ohms	multiply by 1,000,000
amperes to milliamperes	multiply by 1000
amperes to microamperes	multiply by 1,000,000
volts to millivolts	multiply by 1000
volts to microvolts	multiply by 1,000,000

allow one ampere of current to pass with an applied E.M.F. of one volt.

As with voltage and current, the resistance of a material can be expressed in larger or smaller units than ohms. For instance, where the resistance is high, megohms (1,000,000 ohms) are used. Thus a 2,000,000 ohm resistor can more conveniently be referred to as one having a resistance of two megohms.

Similarly, a 50,000 ohm resistor would be equal to 50,000 divided by 1,000,000, equals .05 megohm.

At the other end of the scale is the microhm, which is equal to 1/1,000,000 part of an ohm. This is not very often encountered in ordinary radio work.

OHM'S LAW

Probably the most important and frequently used mathematical relationship in radio is Ohm's Law. This was formulated in 1827 by Georg Simon Ohm, and shows the relationship between current voltage and resistance in a radio or electrical circuit.

To calculate the value of a bias resistor, to calculate the voltage drop across a resistor or to determine whether the measured current agrees with the resistance and voltage values shown on a circuit diagram, the simple statement of Ohm's Law must be known and understood.

A thorough knowledge of Ohm's Law is really the key to all problems involving current, voltage and resistance.

By transposing the terms, Ohm's Law may be expressed in three different ways. The first is as follows:—

$$I = \frac{E}{R} \quad \ldots\ldots\ldots \quad (1)$$

in which

I equals the current in amperes,
E equals the potential or EMF in volts,
R equals the resistance in ohms.

By means of this formula we can calculate the value of the current flowing in any given circuit, provided that we know the resistance of the circuit and the potential applied across it.

If it is desired to have the value of the current in milliamps, then the right hand side of the equation should be multiplied by 1000, so that

$$I = \frac{E}{R} \times \frac{1,000}{1} \quad \ldots \quad (2)$$

in which

I equals the current in milliamps,
E equals the potential or EMF in volts,
R equals the resistance in ohms.

Again, we have the formulae:

$$I = \frac{E}{R} \times \frac{1}{1,000,000} \quad \ldots \quad (3)$$

in which the units of current, potential and resistance are respectively amps, volts and megohms.

Similarly, we have:

$$I = \frac{E}{R} \times \frac{1,000}{1,000,000}$$

$$= \frac{E}{R} \times \frac{1}{1,000} \quad \ldots\ldots \quad (4)$$

TRY YOUR HAND AT THESE:

1. If 100 volts are applied to a circuit containing 500 ohms resistance, what current will flow in this circuit?
2. The current flow in a circuit is 50ma and the DC resistance is 200 ohms, what is the voltage?
3. The voltage drop across a 2 megohm resistor is 100 volts, what is the current in this circuit?
4. What is the resistance of a circuit when the applied voltage is 100 volts and the current flow 20 milliamperes?

For the answer to these problems, turn to page 33.

in which the units of current, potential and resistance are, respectively, milliamps, volts and megohms.

You will note that the basic formula has not been changed. All that has been done has been to multiply or divide by certain constants to allow for the different units of current, potential and resistance.

SECOND FORM

Now by transposing the symbols in formula (1) we obtain the second basic form, which is:

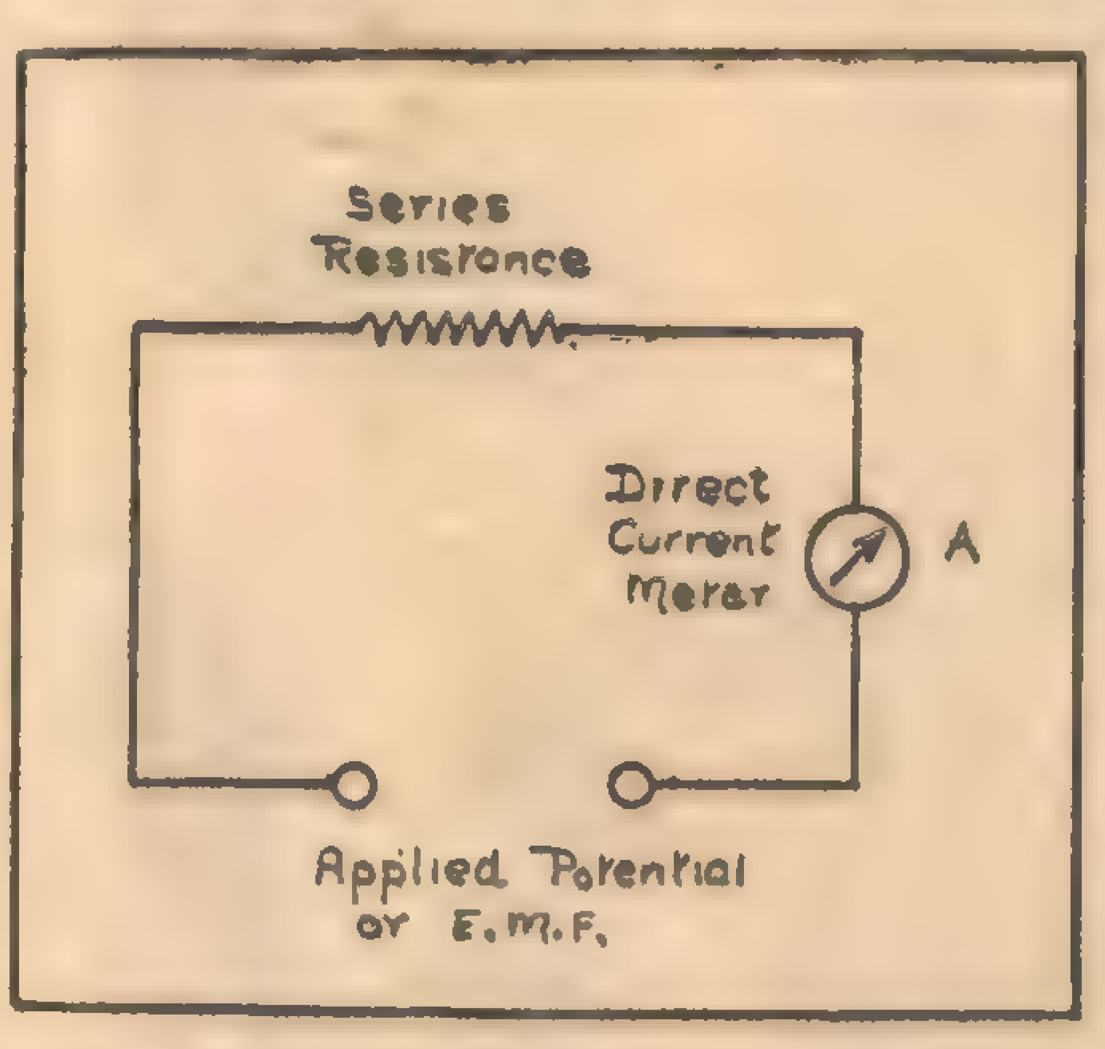
$$E = I \times R \quad \ldots\ldots\ldots \quad (5)$$

With this formula we can calculate the unknown voltages across a circuit by multiplying the known current in amperes by the known resistance in ohms. Should the current be stated in milliamps, then the right hand must be divided by 1000, in which case we have the formula:

$$E = \frac{I \times R}{1,000} \quad \ldots\ldots\ldots \quad (6)$$

If the units of current, potential and resistance are respectively milliamps, volts and megohms, the formula becomes:

$$E = I \times R \times 1,000 \quad \ldots \quad (7)$$



Ohm's law defines the relationship between the voltage, the current and the resistance in a circuit. If any two are known, the third can readily be found. With this circuit in mind, see if you can work out the problems given above.

THIRD FORM

The third and final basic form for Ohm's law is as given in formula (8). The units, as before, are amps, volts and ohms.

$$R = \frac{E}{I} \quad \ldots\ldots\ldots \quad (8)$$

If the units concerned are milliamps, volts and ohms, the formula becomes:

$$R = \frac{E \times 1,000}{I} \quad \ldots\ldots \quad (9)$$

If the units concerned are milliamps, volts and megohms, the formula becomes:

$$R = \frac{E}{I \times 1,000} \quad \ldots\ldots \quad (10)$$

JUST TO MAKE SURE

Just in case you have not everything quite clear: Ohm's Law defines the relationship between current, potential and resistance in a circuit. If any two of these are known, the third can be calculated.

The three basic forms for Ohm's Law are shown in equations (1), (5) and (8). These are arranged, respectively, with the current, the potential and the resistance as the unknown quantities.

In all three of the basic formulae, the units of current, potential and resistance are respectively amps, volts and ohms.

However, it is not always convenient to work with these units, and we often want to make calculations involving other larger or smaller units. The most important of these are the milliamp and the megohm.

Accordingly the basic formulae can be adapted by multiplying or dividing by the appropriate constants. This is precisely what was done to derive the other equations listed.

Still others can be derived for other units, but it is not practicable for us to list them all.

GETTING PRACTICE

The importance of thoroughly understanding this law cannot be too greatly stressed and, for that reason, we suggest that you set about making yourself thoroughly familiar with it. The basic forms, (1) (5) and (8), are the most important, since the other formulae can be derived by simply taking into account the relative magnitude of the other units.

Indeed, it would be an excellent scheme to work out just how these other formulae are derived. The unit conversion tables on the opposite page should be a help in this regard. When you are perfectly familiar with the various units and can interchange them without difficulty, set yourself a few problems for the sake of practice.

You can easily check your answer by using one of the other formulae.

The important point in all this is not merely to agree with the formulae and calculations, but to become so familiar with them that any associated problem can be tackled without hesitation.

ITEMS OF NEWS FROM A WORLD AT WAR

Latest Fighter Has Four Cannon In Nose

BRITAIN'S latest twin-engined fighter plane, the Westland Whirlwind, has four 20-millimetre cannon in its nose.

A single-seater, it has two 850 horse-power Rolls-Royce Peregrine engines, is 32ft. long, 10½ft. high, and has a wing-span of 45ft.

The tail unit is of an unusual design, with the planes placed well above the line of the fuselage, and set towards the top of the fin.

Whirlwinds have been accompanying RAF bombers on long-range flights.

* * *

Plane Steals Pole-Top

THE American pilot of a Spitfire, who was over Northern France recently, brought home the top of a telegraph pole, a foot long, as a souvenir.

He had dived to attack a goods train, and as he rose one wing of his machine hit the pole and a piece of it became wedged between a cannon and the wing.

The nose of the Spitfire missed the pole by six inches.

"I am glad I didn't hit the pole nose-on," the pilot said. "Even a Spitfire can't be expected to bring home the whole of the pole."

New British Tank

THE British War Minister, Captain Margesson, has advised the House of Commons that British factories are working on the production of a tank still larger than existing British types.

He added that they were also working on an anti-tank gun of even higher penetrating power.

NO NEW RADIOS IN U.S.

MANUFACTURE of radio sets and gramophones for civilian use will cease in the United States on April 22.

An order to this effect has been issued by the War Production Board.

The entire facilities of the industry will be converted as quickly as possible to war production.

New Australian Fighter-Bomber

SOME experts believe that the new type of fighter-bomber being produced in Australia might be an improvement on types already in use overseas.

Tooling up for the manufacture of the new aircraft is progressing rapidly, and it would be in production as soon as possible.

RADIO EQUIPMENT IN DOUGLAS B-19

One might be excused for believing this to be the radio cabin of a ship. Actually, it is the radio and control cabin of the monster Douglas B-19 bomber. The picture gives some idea of the amount of valuable equipment which is installed in a modern bombing plane.

Germany Short Of Wool

LOW wool content in uniforms worn by captured Nazi soldiers indicates that stocks of wool Germany accumulated before the war, and those she has since looted from occupied countries, are running out.

Analytical tests have shown that the average German uniform contains 35 per cent. synthetic material and only 65 per cent. wool.

* * *

Army Calls In Old German Guns

GERMAN field guns or howitzers of the last war have been impressed by the Australian Eastern Command.

The guns must be forwarded to the Deputy Assistant Director of Ordnance Stores, Liverpool, within 14 days. Freight will be paid by the Army.

Calibres of the guns required are: 77 millimetre, 4.2, 5.9, and all anti-aircraft guns.

A military spokesman said that the order did not indicate to what use the guns would be put.

In New South Wales there are hundreds of captured guns, which have stood for years in parks and school grounds.

* * *

Sub-Machine Guns

THE Army Minister (Mr. Forde) has signed orders for the immediate manufacture of many thousands of Owen sub-machine-guns for the Australian Army.

To increase production facilities, the Government has made plans to produce more machine tools.

Production of the Sten 9-millimetre sub-machine-gun in Australia is also being considered.

Manufacture of the Sten gun would not interfere with plans for the Owen gun. It would serve as an auxiliary weapon to the Owen. It would use the same type ammunition.

The Sten, which the British Army uses, weighs only 6lb. It can be assembled or dismantled in a few minutes.

Issue of the Sten gun to the Australian Army would mean that Australian troops would be equipped with three different types of sub-machine-guns—the Sten, the Owen, and the Thompson.

* * *

What's This?

THE German Navy is introducing a "new naval anti-aircraft unit," according to a recent report from the German radio.

The "new unit" will be modifications of conventional destroyers and cruisers "to protect all naval formations."

Plane Tally Sets Record

THE total of enemy planes destroyed by British forces in this war has passed the record of over 7900, established in the last war, according to the journal "Aeroplane."

The British have so far shot down 7928 planes with 21,630 personnel.

Britain has lost 4220 planes and 12,013 personnel.

* * *

Bacteria Explode Oil Tanks

A METHOD of causing oil tanks to explode by placing bacteria in them was disclosed recently in New York, at the trial of six Germans charged with espionage.

A Professor Jemima found, while conducting research work with oil bacteria, that certain bacteria placed in oil tanks produced methane gas, creating pressure within the tank, and causing an explosion.

* * *

Canning Foods In Steel

VERY shortly, Britain's canned foods will go into "battle-dress."

It is intended to use wrapperless steel cans, without the usual tin covering.

Housewives will probably dislike the new containers, which look tarnished and rusty, but officials say that unpolished metal will not affect the quality of the food.

The tin shortage is also likely to mean the end of toothpastes and other articles sold in tin tubes. Already several manufacturers are making only powdered and solid dentifrices.

* * *

Oil From Coal

A CORRESPONDENT of the British United Press, on the German frontier, says that Germany is building further synthetic oil plants, the latest in Upper Silesia being capable of producing 1,000,000 tons a year.

After the outbreak of war with Russia German synthetic production of oil increased by 100,000 tons a month.

Synthetic plants are at present consuming one-third of Germany's entire coal output.

* * *

Old Fire Engines For Country

OLD fire engines, out of commission for years, are being reconditioned for use in country centres.

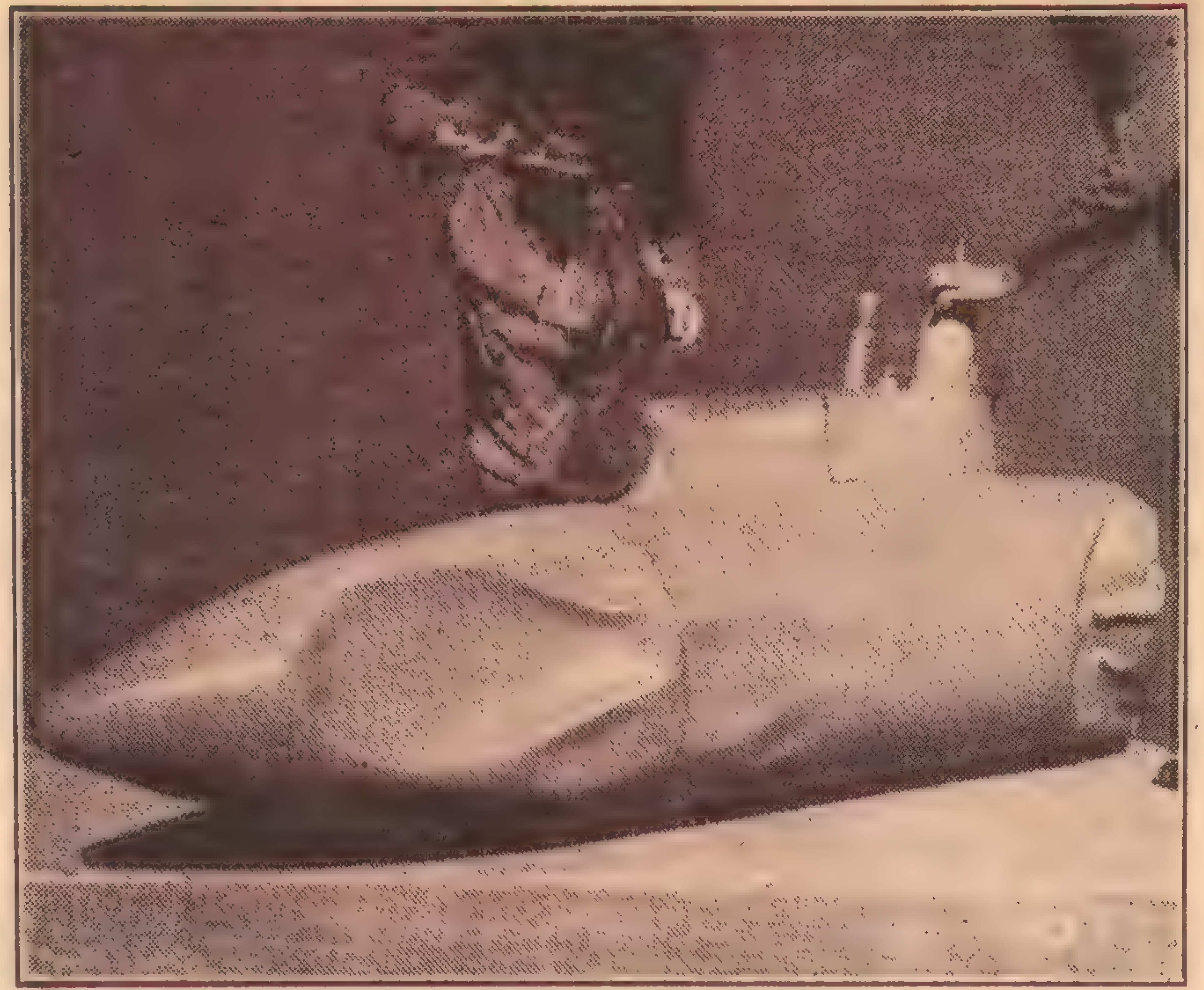
Modern engines, now in the country, will be brought to Sydney.

This is part of a plan to cope with fires caused by enemy action.

Many of the old engines have solid tyres, "gate change" gear levers, and upright steering columns.

However, the old engines are in excellent working order.

EXTRA FUEL TANK FOR JAP FIGHTERS



The Japanese have vastly increased the range of their land-based fighter planes by providing them with detachable petrol tanks, which are quickly released when the planes reach their objective. This particular tank was found at Sourabaya after a Japanese raid. The soldiers standing nearby convey a good idea of its size.

Not So Hot

BRITAIN, in common with the rest of Europe, is having its coldest winter for 50 years.

Between January 1 and February 12, the temperature 20 times dropped below zero. Twice it was 10 degrees below.

BRITISH PARATROOPS ATTACK FRENCH POST

BRITISH parachute troops have sensationally and successfully raided "an important radio location post" on the north coast of France.

A communique issued by the Admiralty, War Office and Air Ministry says the operation was undertaken by joint forces of the Navy, Army and RAF.

"The task was finished according to schedule. The parachute troops were supported in the latter part of their task by the infantry, and were brought back by the Royal Navy," says the communique.

It is the first official news that the enemy is using radio location, the most advanced method of detecting aircraft.

Nazis Build New Line

RECENTLY the German radio announced that a new defence line, similar to the Siegfried Line, was being built on the northern coast of France.

Already 135 miles have been completed, with concrete emplacements and bomb-proof blockhouses.

New British Battleships

BRITAIN'S new 35,000-ton battleships, Anson and Howe, are expected to be ready for sea soon.

This is the interpretation placed on the promise of "important naval reinforcements" by the Prime Minister (Mr. Churchill) in the Commons.

The Anson and Howe, formerly known as the Jellicoe and Beatty, are the last of the five ships of the King George V. class laid down in 1937.

They are sister ships of the Prince of Wales, which was sunk off Malaya on December 10.

The first two ships of the class, the King George V. and Duke of York, are now at sea.

Each ship of the class has a complement of 1500. They are slightly under 740 feet long, and each carries four aircraft launched from one catapult.

Armament is 10 guns of 14in., 16 of 5.25in., four multiple pompoms, several smaller guns, but no torpedo tubes.

The 14-inch guns are a new model, with an effective range greater than that of the 15-inch guns mounted on earlier ships.

The design of the King George V. class ships enhanced defence against air attack with an improved distribution of deck and side armor, and improved under-water protection.

Unofficial reports give the weight of armor as more than 14,000 tons, and the waterline thickness as 16 inches.

Radio Dealers — Service Men

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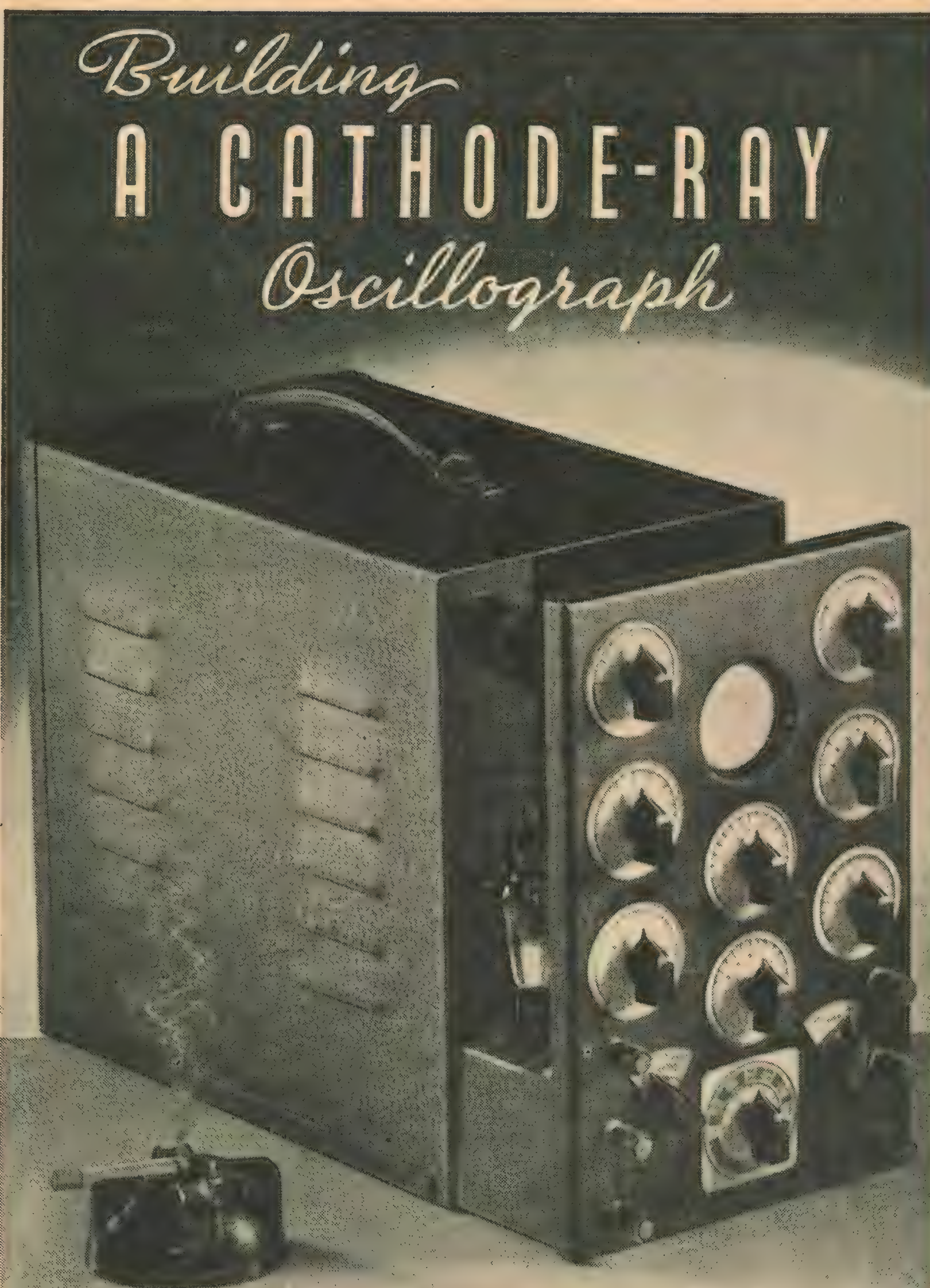
Building A CATHODE-RAY Oscillograph



TWO-INCH CATHODE-RAY OSCILLOGRAPH

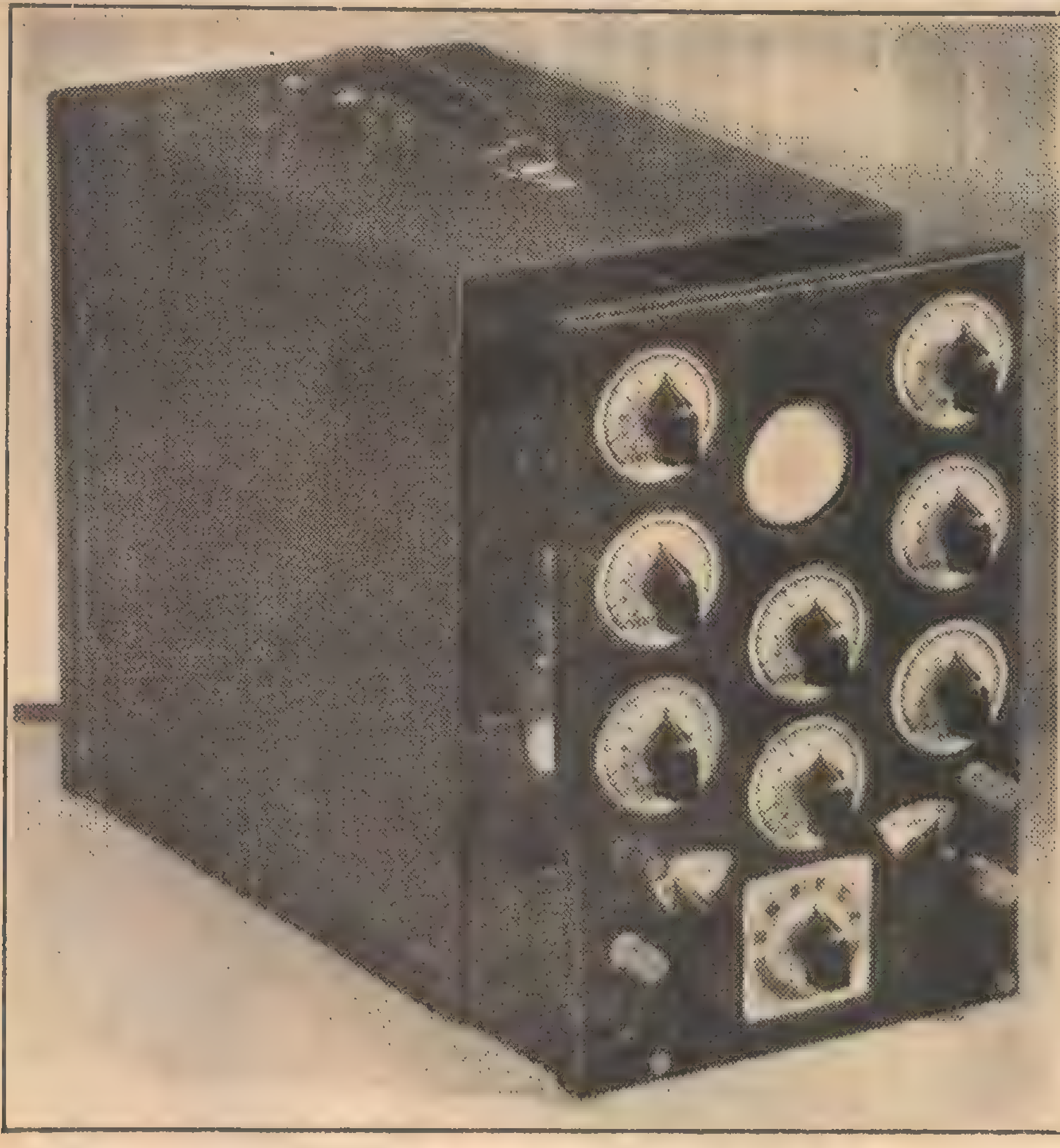


Figure 1. Here is the two-inch cathode-ray oscillograph to which particular reference is made in this article. The complete circuit diagram is given elsewhere. Full constructional data will appear in the next issue.

To those working with amplifiers and high-fidelity radio receivers, there are few instruments as useful as a cathode-ray oscillograph. With such an instrument on hand, much of the usual guesswork is eliminated, and the engineer is able to actually see things taking place.

IN this series of articles, the writer plans to discuss, in considerable detail, the theory, the construction, and the application of a typical cathode-ray oscillograph.

The articles have been prepared, not only for the benefit of those who may desire to build up an oscillograph, but also for those who are interested in the subject from a theoretical point of view

Although, at first glance, a cathode-ray oscillograph appears to be an extremely complicated device, such is not the case. The circuit can be resolved into a number of separate units, whose function is not at all difficult to understand.

Unfortunately, these instruments are not, as yet, widely used by Australian servicemen. This is not entirely due to their cost, since a useful oscillograph can be built up at a price not much in excess of that of a good commercial multimeter or modulated oscillator.

It seems, rather, that the unique versatility and the extreme usefulness of a cathode-ray oscillograph has not yet been fully realised.

In this series of articles, we hope to present sufficient information to permit any serviceman or advanced home-builder to build up for himself a satisfactory instrument. The design to be suggested is not, in any way, inferior to commercial instruments. In actual fact, it includes a number of features not usually included in standard designs.

The oscillograph or "scope" to be described was designed for certain purposes, and the result achieved is quite remarkable, considering that almost all parts used were standard radio parts, readily available from practically any radio shop.

by

H. R. Harant

FEW SPECIAL COMPONENTS

In a few places, where special parts were used in the original design, standard radio parts may often be substituted. This may or may not have an effect on the ultimate performance of the apparatus. However, it is advisable, where best performance is required, to cling to the parts specified, as the amount of money spent on these will certainly prove worth while.

In the first article, it is planned to discuss the circuit without going into constructional details. The matter of construction will be discussed in another issue.

The scope itself is designed around the type 902 Radiotron valve, which is, at present, readily available. The tube has a 2in. screen. Admittedly, 2in. is not a very big size, but there were several reasons to use this particular type.

Firstly, at the time this oscillograph was designed, there were no larger tubes available. Secondly, the price of the 3in. tube was much higher than the advantage of the larger screen would justify.

Another reason was that, for the 902, a high tension supply of 580 volts is ample. This makes it possible to use standard radio parts, instead of costly high voltage condensers and transformers.

As a matter of fact, it should be possible, by sacrificing some brilliancy of the image, to use even an ordinary small power transformer. A special power supply circuit is provided, showing how such a transformer can be used.

PLENTY OF ROOM ON CHASSIS

One last reason for using the Radiotron 902 is that it allows the unit to be made much lighter, so that it is a better proposition for service work.

It may be worth mentioning that the size of the chassis is sufficient to accommodate the type 906 tube, which has a 3in. screen. We heard just recently that this type is now available again at a very much cheaper price, and it may be of interest to some of our readers to know how much extra work and expense is entailed in building an oscillograph incorporating the 3in. tube.

For these readers we shall probably add a few extra notes in the constructional article. Voltages for the 906 come pretty close to the 1000 [illegible] and, naturally, standard radio parts are right out of the question, as far as

THE OPERATING PRINCIPLES EXPLAINED

Figure 2. The Radiotron 902 cathode-ray tube is excellent for a small oscillograph. It is economical as regards cost and space, and does not require unduly high operating voltages. For all that, the image is sufficiently large and clear for most purposes. It is designed for electrostatic deflection.

the power supply for the cathode ray tube is concerned.

The complete circuit diagram for the oscillograph is shown. At first glance it may appear to be rather complicated but we will proceed to discuss the various portions of the circuit in turn.

THE C.R. TUBE

Obviously, the first item to be discussed is the cathode ray tube itself. This contains certain electrodes identical to those of an ordinary radio valve, together with a number of other special electrodes. First of all there is the cathode which initiates the electron stream. This is heated in the usual manner by means of a heater.

In most cathode ray tubes, one side of the filament is connected to the cathode, so avoiding the chance somebody connecting the filament to earth and the cathode to B-. This would create a potential difference, in the case of the 902 of something like 500 volts between the two electrodes. This would almost certainly cause trouble.

INTENSITY CONTROL

The next element in the tube is the control grid. By varying the potential on the control grid with respect to cathode, we can vary the number and the speed of the electrons leaving the cathode. This, in turn, determines the number of electrons hitting the screen of the tube. The more electrons to strike the screen, the brighter the image becomes, so that variation of the bias alters the intensity of the image on the screen.

On leaving the cathode, the electrons do not follow a precise path but tend to spread out in much the same way as beams of light from a candle or other light source.

By enclosing the source of light in a suitable container, it is possible to direct the beams in a certain general direction. However, if we want a concentrated beam of light, it is essential to employ a system of glass lenses.

CONCENTRATING THE BEAM

In a cathode ray tube, it is necessary to have a concentrated beam of electrons, which, on striking the special screen, will cause it to glow at a single spot. To achieve the necessary concentration of electrons, it is necessary to have a system of rings and tubes at various potentials, which have much the same effect on the electron stream as glass lenses on light rays.

The cathode itself is enclosed in a cylinder which is so arranged that the electrons can only travel in the general direction of the screen and past the control grid. The purpose of the latter has already been outlined.

The flight of electrons is subject to influence either by electro-static or electro-magnetic fields. In the majority of cathode-ray tubes electro-static fields are used to concentrate the electrons into a definite beam, which causes a single spot of light where it strikes the fluorescent screen.

In actual practice the electro-static fields are obtained from a system of metallic rings and tubes placed around the path of the electrons and maintained at suitable potentials. The rings and plates are so placed that they do not collect electrons but merely accelerate and control their flight.

FOCUS CONTROL

The actual details of these directing electrodes and the potentials at which they operate naturally vary with the particular tube type. It is usual to have the potential on at least one electrode variable, so that it can be adjusted for the best concentration of the electron beams. This control is known as the "focus" control.

The complete assembly of electrodes for producing the electrons and focusing them into a beam is commonly known as the "electron gun." Without elaborating on it, the name is quite expressive.

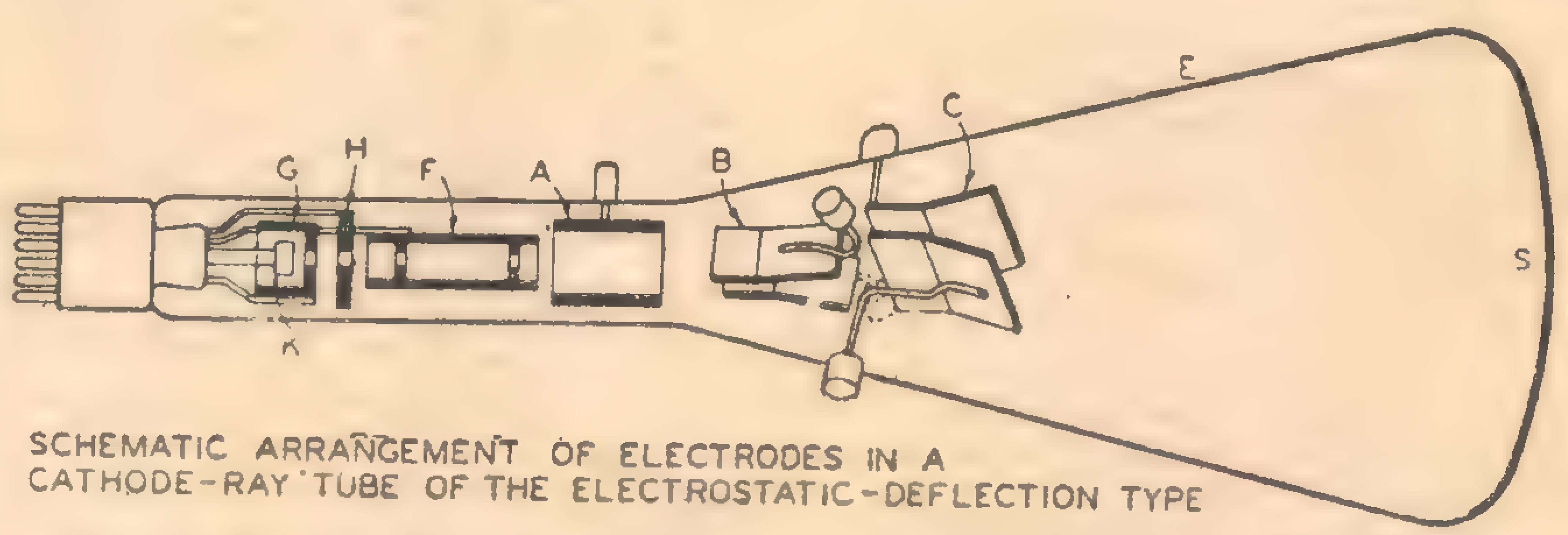


Figure 3. Depicting the arrangement of the electrodes in a typical large cathode-ray tube, designed for electrostatic deflection. The key to the letters is as follows: (E) glass envelope, (K) cathode, (G) grid 1 for intensity control, (H) electrode for accelerating the electrons, (F) focusing electrode, (A) high voltage anode, (B) and (C) deflector plates and (S) the fluorescent screen. In the case of the 902, two of the deflector plates are connected internally to the high voltage electrode, the other two being brought out to pins on the base.

★ COMPLETE SCHEMATIC CIRCUIT DIAGRAM ★

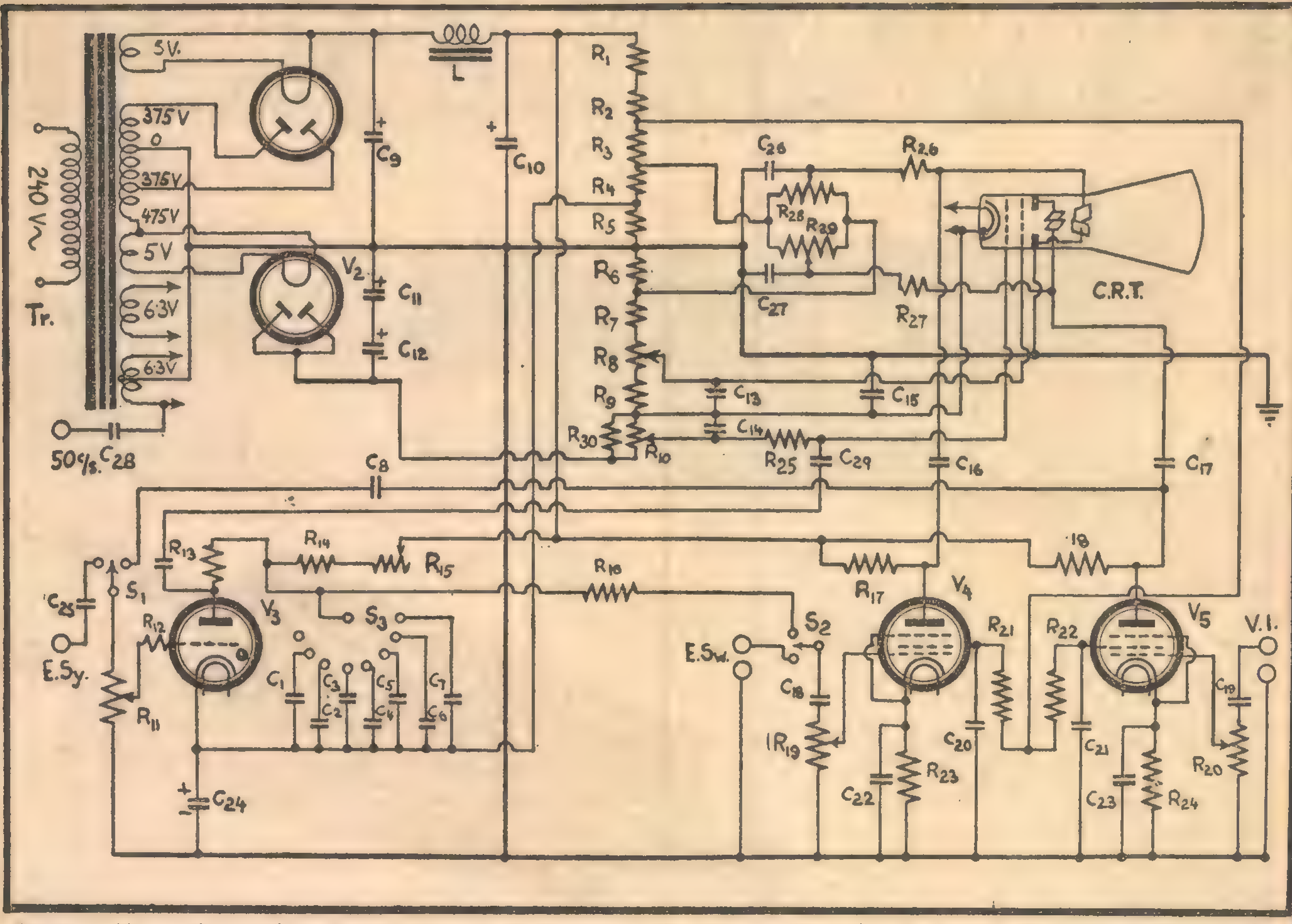


Figure 4. Here is the complete circuit diagram for the Two-inch Cathode-Ray Oscillograph. In the text, the various sections of the circuit are discussed separately and in detail. A wiring diagram is not given, since an instrument such as this is usually only required by those having sufficient knowledge to work directly from a schematic circuit diagram. There is one slight error in that the unmarked condenser alongside R13 should not appear in the circuit.

COMPLETE LIST OF PARTS AND KEY TO CIRCUIT VALUES

RESISTORS

R1 10,000 ohm 2 watt resistor.
R2 15,000 ohm 2 watt resistor.
R3 5000 ohm 1 watt resistor.
R4 15,000 ohm 2 watt resistor.
R5 600 ohm 1 watt (wire wound).
R6 50,000 ohm 1 watt resistor.
R7 50,000 ohm 1 watt resistor.
R8 25,000 ohm potentiometer.
R9 15,000 ohm ½ watt resistor.
R10 1 megohm potentiometer.
R11 250,000 ohm potentiometer.
R12 25,000 ohm ½ watt resistor.
R13 500 ohm 1 watt resistor.
R14 250,000 ohm 1 watt resistor.
R15 1 megohm potentiometer.
R16 1 megohm ½ watt resistor.
R17 100,000 ohm 1 watt resistor.
R18 100,000 ohm 1 watt resistor.
R19 1 megohm potentiometer.
R20 1 megohm potentiometer.
R21 250,000 ohm ½ watt resistor.
R22 250,000 ohm ½ watt resistor.
R23 1000 ohm 1 watt resistor.
R24 1000 ohm 1 watt resistor.
R25 1 megohm ½ watt resistor.
R26 2 megohm ½ watt resistor.
R27 2 megohm ½ watt resistor.
R28 1 megohm potentiometer.
R29 1 megohm potentiometer.
R30 25,000 ohm ½ watt resistor.

CONDENSERS

C1 0.0008 mfd mica condenser.
C2 0.002 mfd mica condenser.
C3 0.005 mfd mica condenser.
C4 0.015 mfd mica condenser.
C5 0.05 mfd paper condenser, 600PV.
C6 0.15 mfd paper condenser, 600PV.
C7 0.5 mfd paper condenser., 600 PV.
C8 0.001 mfd mica condenser.
C9 8 mfd dry electrolytic con., 600 PV.
C10 8 mfd dry electrolytic con., 600 PV.
C11 8 mfd dry electrolytic con., 600 PV.
C12 8 mfd dry electrolytic con., 600 PV.
C13 0.1 mfd 400 V paper con.
C14 0.1 mfd 400 V paper con.
C15 0.1 mfd 600 V paper con.
C16 0.25 mfd 400 V paper con.
C17 0.25 mfd 400 V paper con.
C18 0.25 mfd 600 V paper con.
C19 0.25 mfd 600 V paper con.
C20 0.25 mfd 400 V paper con.
C21 0.25 mfd 400 V paper con.
C22 0.003 mfd mica con.
C23 0.003 mfd mica con.
C24 25 mfd 40 PV electrolytic con.
C25 0.25 mfd 600 V paper con.
C26 0.1 mfd 400 V paper con.
C27 0.1 mfd 400 V paper con.
C28 0.25 mfd 400 V paper con.
C29 0.0005 mfd mica con.

VALVES

V1 '80 valve.
V2 '80 valve.
V3 884 valve.
V4 6J7G valve.
V5 6J7G valve.

OTHER COMPONENTS

L 30 Henry 15 ma choke.
Tr Transformer as specified in text.
S1 SPDT semi-rotary switch.
S2 SPDT semi-rotary switch.
S3 12-position rotary switch.
6 terminals.
2 terminal strips for mounting.
11 black pointer knobs.
2 4-pin valve sockets.
4 octal valve sockets.
1 special chassis.
Solder, solder lugs, ⅛in. bolts and nuts, mains cord, hook-up wire, bus bar.

Obviously, a stationary spot on the screen serves no useful purpose. We must have a means of inducing it to move about in sympathy with certain external applied voltages and/or currents.

DEFLECTING THE ELECTRON BEAM

As stated earlier, electrons are subject to influence by electro-magnetic or electro static fields. Thus, by creating electro-magnetic or electro-static fields in the immediate vicinity of the electron beam, it is possible to deflect it in various directions.

With some cathode-ray tubes, the desired result is achieved by arranging coils around the neck of the tube and passing through the coils current from the circuits whose behavior is to be observed. This is electro-magnetic deflection.

The majority of cathode-ray oscillographs for service or general laboratory work utilise the other principle of electro-static deflection. The 902 tube is especially designed for this type of deflection. Some cathode ray tubes are designed to allow electro-static deflection in one direction and electro-magnetic deflection in the other.

In the 902 and similar tubes, two pairs of deflection plates are arranged at right angles to one another just beyond the electron gun. When all the plates are at the same potential, the effect on the beam is nil. However, if the potentials between opposite plates differ, the beam will be deflected and will no longer hit the screen at the same spot.

The higher the potential difference between opposite plates, the further the spot will be removed from its previous position. If we apply a DC voltage between one pair of plates, the spot will jump to one particular position and stay there.

On the other hand, as soon as we apply an A-C potential, the spot will no longer remain stationary, but will continually change its position according to the instantaneous value of the A-C potential. Instead of a spot, a line will now appear on the screen if the frequency exceeds about 16 c/sec. The human eye fails to follow the movements of the spot at higher frequencies than this.

VERTICAL AND HORIZONTAL DEFLECTION

Both pairs of plates can affect the beam simultaneously. While one pair deflects the beam vertically, the other pair work horizontally from left to right. As the two are quite independent one from the other, the spot can be directed to any position on the screen of the tube.

In the 902 and similar tubes one of each pair of deflector plates is connected internally to the high voltage electrode. To maintain the beam in a central position, it is therefore necessary to have the opposite deflector plates at the same potential as the high voltage electrode.

To deflect the beam the potential of the independent deflector plates must be varied about this initial potential. The implications of this will be apparent later.

On these principles is the functioning of the oscillograph based. The usual procedure is, to impress the voltage to be examined on one pair of plates, generally the vertical ones, and on the other pair we put the so-called scanning voltage, sometimes referred to as the linear sweep voltage.

This voltage is generally produced inside the oscillograph for greater convenience. The sweep voltage is a very complex form of oscillation and is generated by a "saw-tooth" oscillator.

The "saw-tooth" oscillator, as the name suggests, produces a voltage which rises gradually, in a linear fashion, and then falls off almost momentarily. This voltage, applied to the horizontal deflection plates in our CR tube, causes the beam to travel comparatively slowly from left to the right, but to jump back almost in an instant, as soon as the cycle is finished.

If there were no voltage on the vertical deflection plates, a single line would be traced, which should be approximately across the middle of the screen. As soon as a DC voltage is applied to the vertical deflection plates as well, the line will no longer remain in the middle of the tube, but it will jump up or down, according to the voltage applied.

TRACING A SINE WAVE

If an alternating voltage is applied to the vertical deflection plates, the image obtained will show the familiar Sine wave. How this comes about is not difficult to understand. Assume that the sweep and alternating voltage have the same frequency.

With the spot just commencing to move from left to right, the instantaneous voltage on the vertical plates is at zero potential. As the spot travels across the screen in a horizontal direction, the voltage on the vertical pair rises, to reach a maximum position after

HERE IS THE POWER SUPPLY CIRCUIT

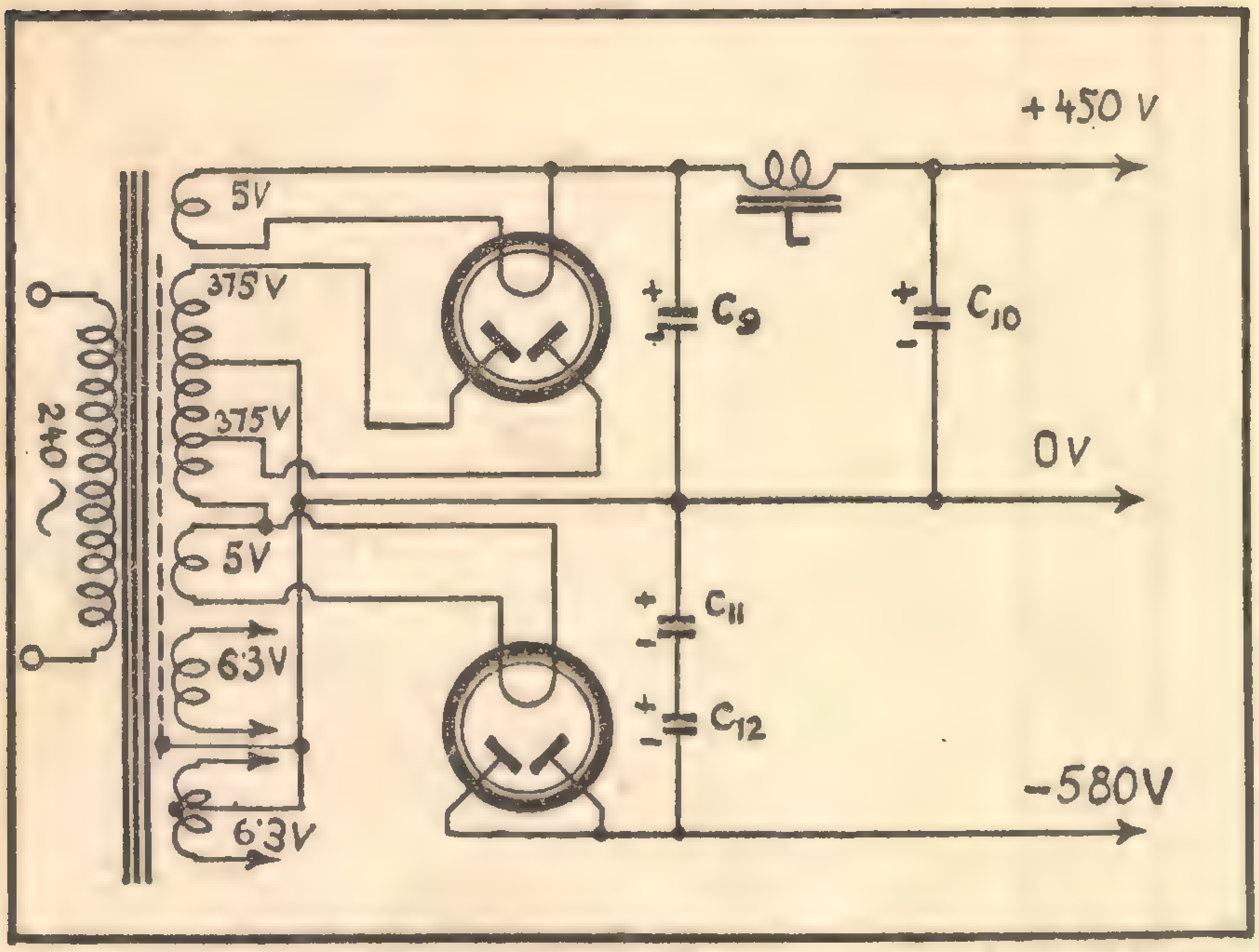


Figure 5. Here is the power supply circuit. The upper portion of the circuit is quite conventional. It utilises a full-wave rectifier, a conventional filter system, and delivers an output voltage of plus 450 volts for the amplifiers and for the sweep oscillator circuit. The lower valve operates as a half-wave rectifier, employs a simple capacitance filter and delivers an output voltage of minus 580 volts for the cathode-ray tube.

one quarter of the screen has been traversed.

During the next quarter, the spot still moving to the right, the voltage under examination (vertical plates) decreases, to reach the zero line again. Now the voltage changes polarity, which means that it will continue below the zero line to reach a maximum at three-quarters across the screen.

TIME-BASE FREQUENCY

During the last quarter of the journey across, the voltage falls again in its absolute value, and approaches zero, which it finally reaches just when the horizontal sweep has finished. The spot now flicks back across the screen, and the whole process is repeated again and again until interrupted.

It is obvious, that such a simple curve appears on the screen only if the time-base frequency and the frequency to be observed are exactly the same, that is, if perfect synchronism exists, as it is called.

If the sweep voltage is a submultiple of the phenomenon under observation, more than one wave will appear on the screen. For sweep frequencies which bear no simple relationship to the frequency on the vertical plates, the pattern will be much more complicated. An attempt will be made to interpret several patterns on the screen in a subsequent article.

THE POWER SUPPLY

It now remains to examine in detail the complete circuit and to resolve it into its several units.

In the upper left-hand corner of the main circuit diagram is the power supply unit. To make things clearer, this has been redrawn in a separate diagram and disentangled from the rest of the circuit.

It will be seen that the transformer specified is a special one, having two 5.0 volt windings, two 6.3 volt windings, and a special high voltage secondary winding, with four terminals. There are two rectifier valves. The reason for this will be apparent presently.

For the sake of those who may desire to make use of a standard type of transformer, an alternative circuit arrangement is shown. The standard transformer will certainly allow results to be achieved, but there are certain objections to its use.

The power supply in a cathode-ray oscillograph has to supply voltage for the cathode-ray tube itself and for the voltage amplifier and the sweep-oscillator circuit.

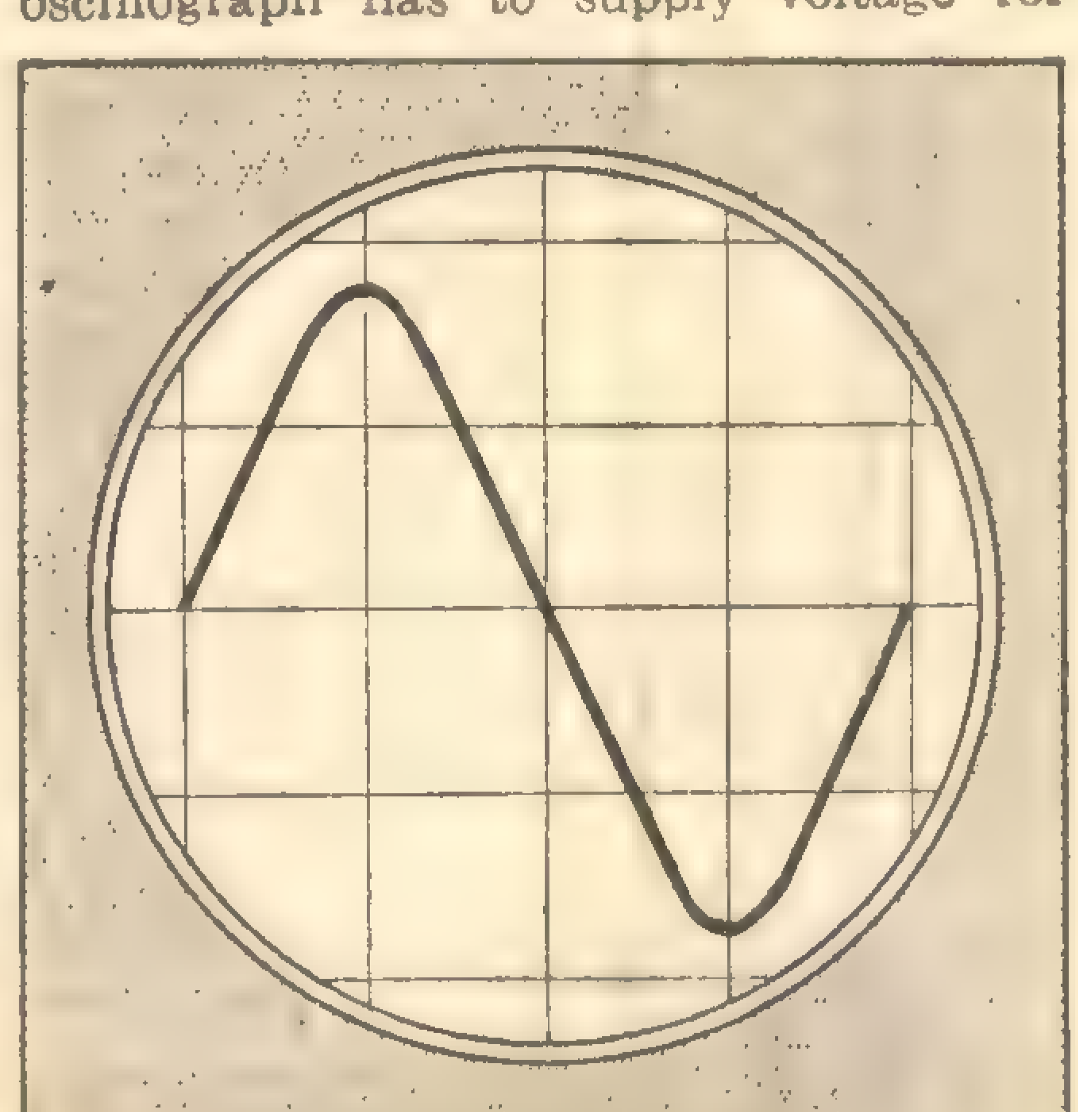


Figure 6. This gives you some idea of the appearance of a single sine wave on the screen of a cathode-ray tube. In the case of the 902 the trace is green. The fine lines have simply been drawn in to divide the screen into equal segments for purposes of comparison.

For the sake of convenience and safety, the deflection plates of the CR tube must be maintained at or near earth potential. The only way this can be accomplished is to have the cathode of the CR tube negative with respect to earth by an amount equal to the supply voltage.

POSITIVE AND NEGATIVE SUPPLY VOLTAGES

This means, in turn, that the power supply has to be arranged so that it will deliver a voltage approaching 600 volts, with the positive side of the supply at earth potential. This is just the reverse of ordinary receiver and amplifier practice, where the negative side of the supply is at earth potential.

The use of the same supply for the voltage amplifiers and for the sweep oscillator would be inconvenient, and it is desirable to have a separate supply for these units, with the negative terminal at earth potential, in the usual way.

This means that the power supply must be arranged to provide supply voltages both positive and negative with respect to earth. The desired result is usually achieved by using a power transformer with a single high tension winding and two distinct rectifier valves.

POSITIVE SUPPLY

If we look at the diagram, we find that the top part of the circuit is quite a standard arrangement. Equal a-c voltages are fed to the two plates of a full wave rectifier, which happens to be type 80 in this case. The centre-tap of the high voltage winding is connected to earth, and forms the negative terminal of the d-c output.

The rectified positive pulses are taken from the cathode or filament of the rectifier, and, after smoothing by a conventional condenser-choke-condenser filter, we have a smooth d-c supply of about 450 volts.

This sounds rather high for the plate supply of the amplifier valves, but we must remember that they are resistance coupled and there is a considerable voltage drop across the plate load resistors.

The interesting part of the power supply circuit is the lower portion, supplying the voltage to the CR tube. The two plates of the lower rectifier are connected together, so that it operates as a half-wave rectifier.

NEGATIVE SUPPLY

Moreover, the filament is tied to one side of the high tension winding, the output to the filter being taken from the plates. You will see that the lower rectifier will only conduct during portion of the alternate half cycles when the filament is swung negative with respect to earth.

When the rectifier conducts, the condenser network C11 and C12 is charged almost to the peak value of the a-c input voltage. The end of the network joined to the plates is negative with respect to earth.

For best results with the 902 CR tube, we want a high tension supply voltage approaching 600 volts. If we had a secondary voltage of only 375 volts, the d-c output voltage would only be about 500 volts. In order to improve matters, the special transformer had extra turns on one side of the secondary, allowing the lower rectifier to deliver the desired voltage.

Of course, the transformer could have a secondary voltage of 475 volts per side, but steps would then have to be taken to reduce the output voltage from the upper rectifier. This would be a nuisance, and the extra wire on the transformer would have served no useful purpose but would only have complicated the design.

CURRENT DRAIN LOW

The current drain of the CR tube is so low that the extra load on one-half of the secondary winding can be neglected. Furthermore, the low current drain allows us to obtain adequate filtering with nothing more than a single condenser network across the output of the rectifier.

Two condensers in series were used in this position for the very simple reason that a single condenser capable of withstanding the necessary voltage is not readily available.

In the original oscillograph, tubular electrolytic condensers were used in this position. The use of wet can-type condensers is not recommended. Both cans would need to be well insulated from earth and there would be a distinct danger of receiving a nasty shock if the can and chassis were touched simultaneously.

There did not appear to be any necessity for connecting bleed resistors across the two condensers. It was found that, after a few minutes of operation, the two condensers adjusted themselves so that the voltage across them was practically equal. However, it is wise to use two condensers of the same make, and, of course, of the same capacitance.

Across the output from each rectifier system is a divider network to supply intermediate voltages where necessary and to act as a bleed.

ALTERNATIVE CIRCUIT

An alternative circuit diagram is also shown, using an ordinary receiver-type transformer. Many of these transformers have only a single 6.3 volt winding, one 5.0 volt winding, and a high tension winding delivering about 385 volts either side of the centre-tap. Therefore, the exact circuit previously specified is out of the question.

The function of the circuit, of course, remains the same, since the requirements of the oscillograph are unaltered.

For a start, there is only one 5.0 volt winding, so that it is no longer practicable to use two type 80 rectifiers However, there is another type of rectifier, having a 6.3 volt heater rating, namely, the 6X5-GT. This can be substituted for one of the 80 rectifiers.

The insulation between the heater and the cathode of the 6X5-GT is supposed to withstand a voltage of 450 volts, so that, at a pinch, the same filament winding can be used for the

ALTERNATIVE POWER SUPPLY CIRCUIT

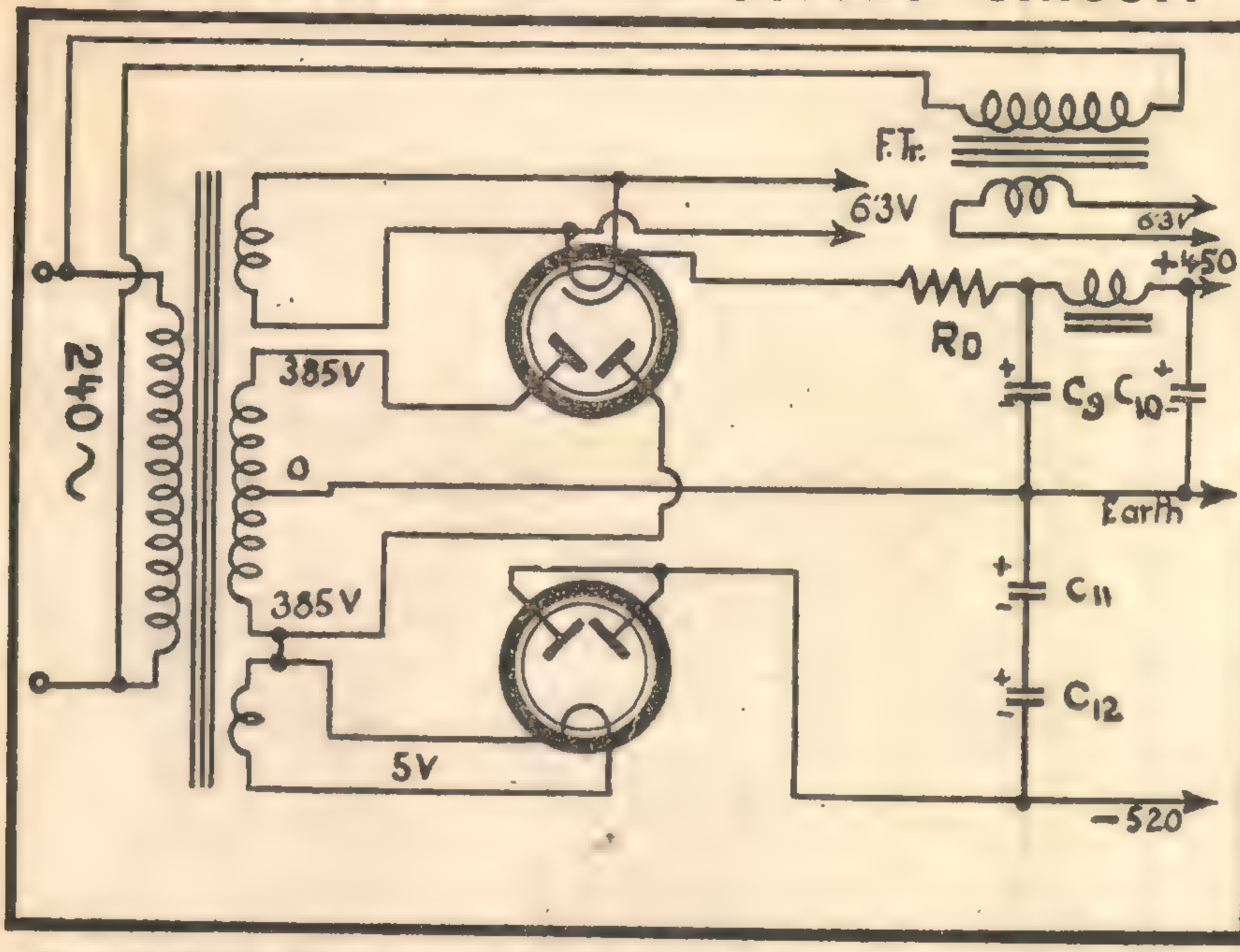


Figure 7. If it is found impossible to obtain a power transformer to the recommended specifications, a standard receiver-type transformer can be pressed into service. The results may not be quite as good, for reasons explained in the text. Note that a separate filament transformer, with well insulated windings, is used for the cathode of the CR tube.

filament of the rectifier and the filaments of the voltage amplifiers. If the transformer happens to have two separate 6.3 volt filament windings, so much the better. The two windings can be used for the separate heaters.

For the heater of the CR tube, it is necessary to obtain a separate 6.3 volt transformer, which will need to be able to withstand the necessary d-c potentials between the windings.

VOLTAGE RATHER LOW

The d-c output voltage using a 385 volt transformer is lower than the desirable figure and a sharper image is to be had when using a transformer delivering a higher voltage. At the same time, this would result in an unnecessarily high voltage from the other rectifier. However, this can readily be reduced by including a dropping resistor, Rd, in the position shown (Figure 7).

The exact value would have to be determined experimentally. It would need to be adjusted so that the voltage across the second electrolytic condenser C10 was about 450 volts.

FLUX DENSITY

Before concluding the description of the power supply unit, there is one other point worthy of special mention. Standard power transformers for radio receivers are designed on a basis of a flux density of from 10,000 to 12,000 lines per square centimetre.

This is far higher than is desirable with laboratory equipment of this type. It is advisable for a cathode-ray oscillograph not to go higher than about 7000 to 8000 lines per square centimetre. When ordering a special transformer, it is well to mention this point. Also ask for electrostatic shields between the primary and the secondary windings.

If you can possibly manage to do so, obtain a power transformer designed for the purpose. An ordinary transformer will allow some results to be obtained, but it can prove a source of trouble.

It may be helpful in very severe cases of hum, to mount the transformer vertically instead of flush on to the chassis. This greatly reduces the eddy current effects which are quite likely to appear with poor transformers.

Finally, it shall be mentioned that the choke used for the filter circuit in the voltage amplifier stages is a standard 30 henry, 15mA choke. If possible, it should be of shielded construction. A poorly-shielded choke can cause a lot of trouble, sometimes very difficult to find.

It is advisable to mount the choke-core at right angles to the core of the transformer in order to avoid hum-pick-up due to magnetic induction. It is often a good idea, especially if a shielded choke cannot be obtained, to mount the choke under the chassis, provided there is sufficient room.

DEFLECTION AMPLIFIERS

Having considered the CR tube itself and the power supply equipment, we can pass on to a discussion of the deflection amplifiers. First, let us consider why deflection amplifiers are necessary.

According to the data supplied with the 902 tube, the deflection sensitivity, with a high tension voltage of 600 volts, is 0.19 and 0.22 mm. per volt respectively, for the two sets of deflector plates. The higher figure of sensitivity is for the pair of plates situated nearer the "gun."

This means that a potential difference of one volt between opposite plates will cause the spot to be deflected by either 0.19 or 0.22 millimetre, depending on which pair of plates is concerned.

DEFLECTION VOLTAGE

To shift the spot from its normal position in the centre of the screen to the extreme edge would represent a deflection of about 25 millimetres. A simple calculation shows us that this would represent a deflection voltage of 25 divided by 0.19 equals 132 volts. For the other plates, the figure would be 113.5 volts.

Such a deflection voltage is not readily available from the sweep oscillator.

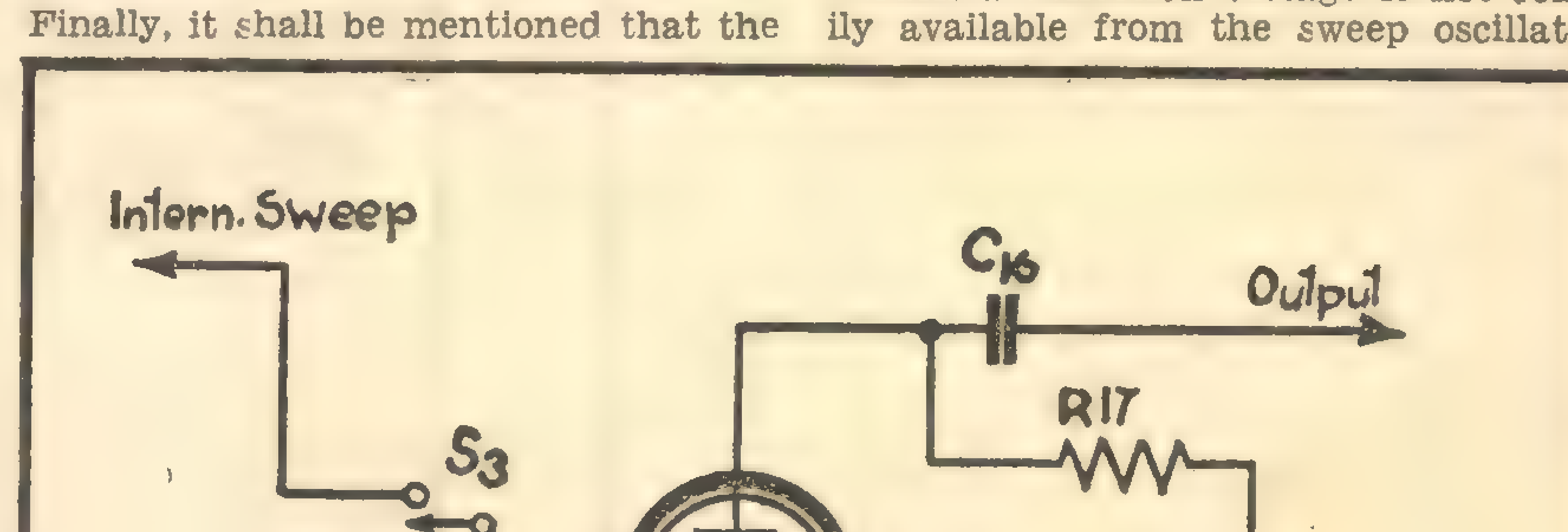


Figure 8. To deflect the spot right across the screen, a deflection voltage of well over 100 volts is required. This voltage is not readily available from the sweep oscillator, nor is it always available from the circuit under examination. Hence the need for deflection amplifiers. Note that the circuit is basically the same as a pentode voltage amplifier in an ordinary receiver or amplifier.

Nor it is desirable to limit the use of the oscillograph to the observation of input sources capable of delivering upwards of 100 volts. On the contrary, the oscillograph is most frequently used for the observation of very small voltages.

To overcome this difficulty it is necessary to include amplifiers to step up the small input voltages sufficiently to give a reasonable deflection of the spot. One of the amplifiers can also serve to amplify the output from the sweep oscillator.

INPUT CAPACITANCE

For the sake of clarity we have redrawn one of the amplifier circuits. There are definite reasons for choosing pentode valves. Consider first the input circuit with the volume control R19. In parallel with R19 is the input capacitance of the amplifier valve. This capacitance may cause a certain amount of frequency discrimination.

The effect is negligible with the volume control turned well towards the "off" position. In this case the input capacitance is shunted by a comparatively low resistance, which minimises the frequency discrimination.

When the control is full on, or nearly so, the valve input capacitance is virtually in parallel with the input source. This may cause trouble, although it will be unimportant if the input source is of low impedance or if the input source itself has considerable parallel capacitance.

TRIODES AND PENTODES

The greatest difficulty is likely to occur at medium settings of the control where there is considerable resistance in series with the grid circuit and considerable resistance between the grid and earth.

As this input capacitance, with triode valves, can rise to as much as 100 mmf., due to "Miller" effect, the attenuation can become quite considerable. By using a pentode valve, the input capacitance can be kept as low as 0.01 mmf.!

One warning! Do not use shielded leads inside the oscillograph! There should be no need to do so if the instrument is carefully built. There should be no grid hum, nor should the deflection plate leads pick up hum. If the spot is blurred, due to hum pickup, it is most likely the result of magnetic fields.

HIGHER GAIN

A second reason for using pentodes is that they permit higher stage gain to be achieved. This high stage gain is often useful. For example, with the shift adjusted to bring the zero line to the very bottom of the screen, the additional gain allows one to spread the tops of the waves right over the screen without undue distortion.

The usual cathode bypass condensers are omitted. This introduces a certain amount of negative current feedback at audio and supersonic frequencies, which is useful in maintaining more or less constant the amplification at different frequencies.

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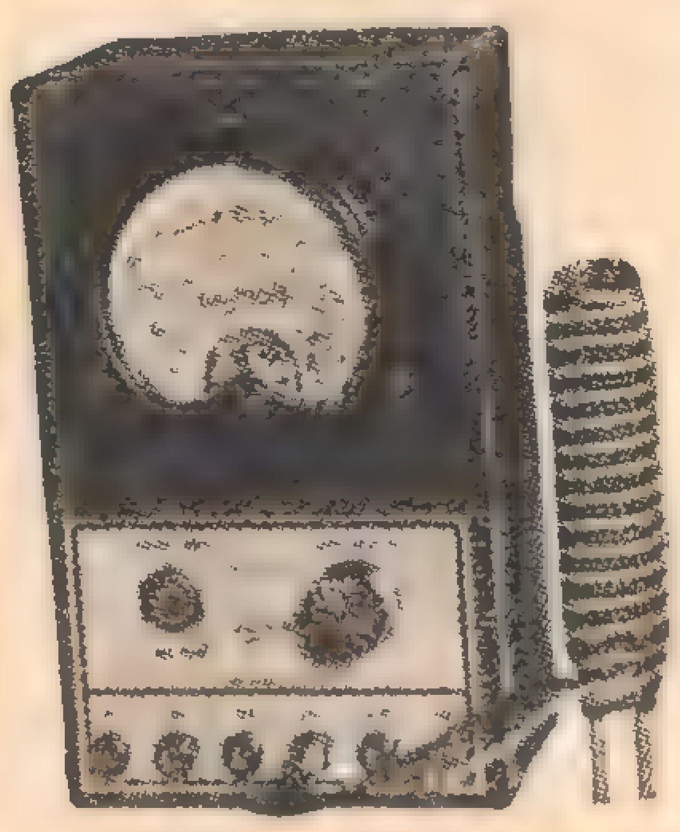

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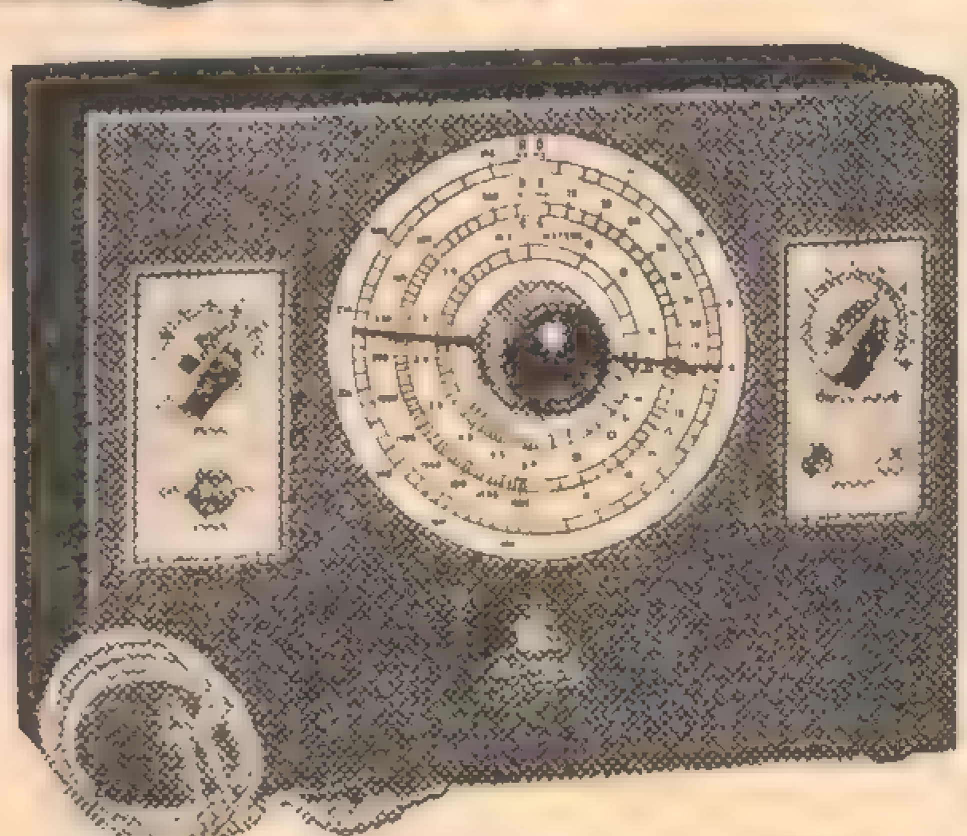

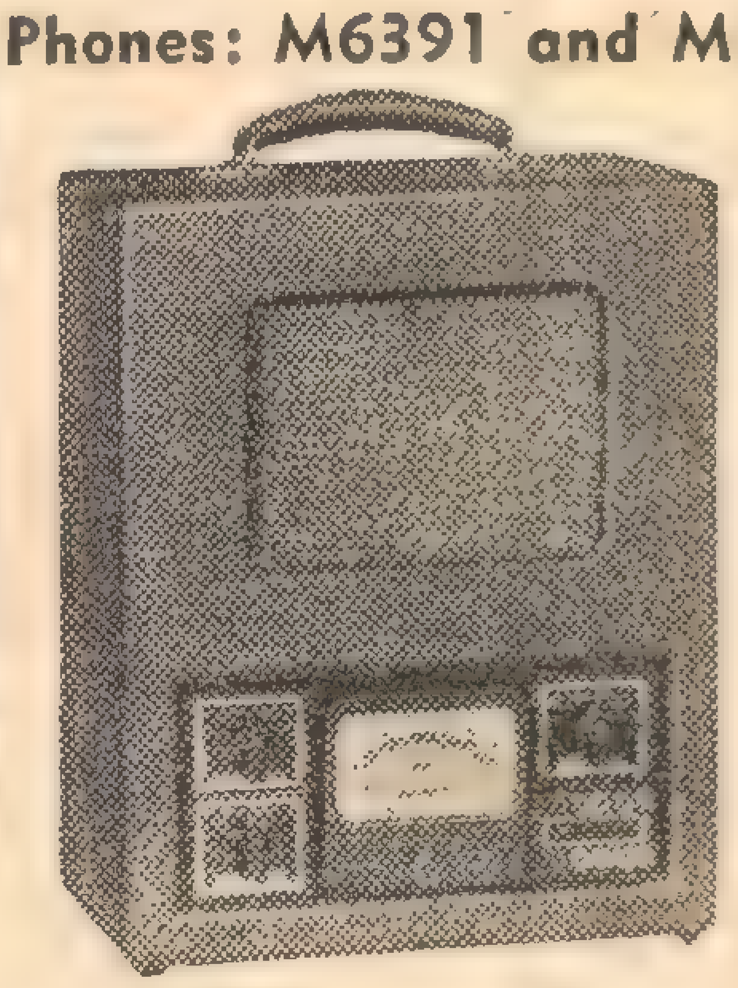

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Apart from this, the circuit is more or less conventional. The plate load resistance is 100,000 ohms. The screens are supplied from a tapping on the voltage divider network and through a suitable dropping resistor R, which limits the current and serves to decouple the screen circuit. The screens are bypassed to earth.

DECOUPLING UNNECESSARY

In the original oscillograph, it was not found necessary to individually decouple the plate supplies of the two 6J7-G valves, as there was no trace of troublesome synchronisation effects. However, in other cases it may be found desirable.

The amplifiers are connected through large coupling condensers to one of each pair of deflector plates. The remaining deflector plate in each pair is connected within the tube to the high voltage electrode.

For the sake of safety and convenience, there is quite a point in having the deflector plates at or near earth potential. Since two of the deflector plates are already connected within the tube to the high voltage electrode, we have no option but to earth this electrode and maintain the cathode at a high negative potential with respect to earth. Hence the need for a special power supply circuit.

Since the deflector plates are at or near earth potential, they can be safely brought out to terminals without the danger of the operator receiving a shock.

SPOT SHIFTING

In actual fact, the deflector plates can be brought out to terminals on the back of the oscillograph for direct connection to an external circuit. This avoids difficulties as a result of circuit capacitances.

It often happens that, as a result of inaccuracies in the construction of the CR tube, the spot does not strike the exact centre of the screen, despite the fact that all deflector plates may be at earth potential. This is often undesirable, and it is handy to have a means of adjusting the initial position of the spot.

On the other hand, if it is desired to examine in detail a certain portion of a wave, it is handy to be able to shift the initial position of the spot in order to have the particular portion of the wave well spread over the centre of the screen.

The desired result may be attained by returning the two independent deflector plates, not to earth, but to points in the circuit whose potential can be varied above and below earth potential.

TWO CONTROLS

In this oscillograph, the two deflector plates are connected to the moving arms of two separate potentiometers. The outer terminals of each of the potentiometers are connected to points in the circuit plus 160 volts and minus 160 volts with respect to earth.

Thus, by rotating the potentiometer controls, the potential of the respective deflector plates may be varied within the limits of from plus 160 volts to minus 160 volts with respect to earth.

This means that the spot may be shifted in any direction by suitable manipulation of the controls. In fact, if the controls are turned to their limits, the spot will be shifted off the screen altogether!

The voltages for the two spot shift potentiometers are obtained from suitable points on the two divider networks.

In the original oscillograph, the shift controls were two odd potentiometers originally designed as mixer controls. They were centre-tapped and had a resistance of 1.0 megohm either side of the centre-tap. The law was rather more linear than logarithmic, which was an advantage.

However, ordinary 1.0 megohm potentiometers can quite well be pressed into service. The current flowing will be 0.3 milliamp. and the dissipation 0.1 watt.

TIME-BASE OR SWEEP OSCILLATOR CIRCUIT

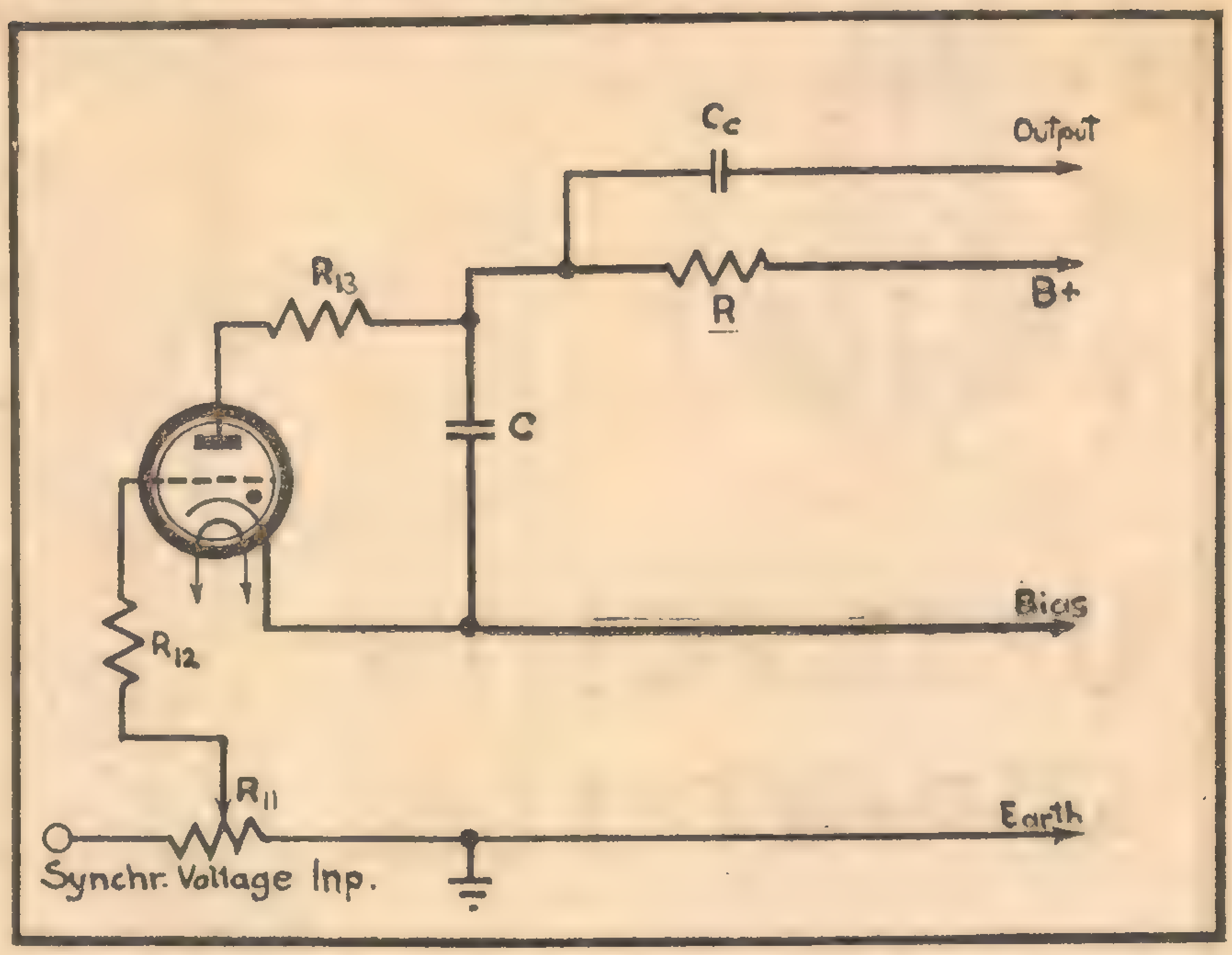


Figure 9. Showing the essential details of the timebase or sweep oscillator circuit. The condenser C is charged through the resistor R and discharged by the gaseous valve. The frequency with which this operation occurs is governed by the values of C and R, which can both be varied in the finished oscillograph. Synchronisation pulses are fed to the grid by way of the network R11 and R12. The output voltage is taken from the plate circuit by way of the coupling condenser Cc.

THE SWEEP OSCILLATOR

The last important item to be considered is the sweep oscillator or "time base," as it is often called. It is the job of the sweep oscillator to provide a "saw-tooth" voltage, which will move the spot evenly from left to right at a desired rate and then flick it back again to the starting point to repeat the movement over and over again.

The desired saw-tooth voltage may be obtained from either a "hard" or a "soft" time base circuit. In the former type, a number of ordinary vacuum tubes are used. In this oscillograph we made use of a "soft" time base circuit. In other words, the associated thermionic valve is not a vacuum type but contains a small amount of inert gas.

Imagine a condenser connected in series with a resistance. If the ends of this network are connected to a potential, the condenser will charge up until the potential across it ultimately reaches the same figure as the potential of the supply.

At first, the relationship between time and charging current is approximately linear. However, when the potential across the condenser is about 40 per cent. of the source, the curve begins to depart noticeably from a linear function and tapers off, the charging current decreasing all the while.

DISCHARGE DEVICE

If, at a certain critical point on the curve, the condenser is short-circuited for a brief period, it will discharge rapidly. However, as soon as the short-circuit is removed, the condenser will begin to charge up again as before. Provided that the condenser is shorted at regular intervals and at the same point on the curve, the voltage across the condenser will approximate a saw-tooth wave form.

The speed of the charging will only depend on the value of the resistance and on the capacitance of the condenser. The larger the resistor and the higher the capacitance, the slower the voltage across the condenser will rise. The time of discharge is substantially independent of these components provided the resistance of the auxiliary short-circuit path is sufficiently low.

GASEOUS DISCHARGE TUBES

Mechanical shorting devices are out of the question, and some electrical discharge device must be used. Fortunately, the grid-controlled gaseous discharge tube, or thyratron, is exactly what is required.

The thyratron can be compared to a neon tube. It is commonly known that the neon tube does not light up until

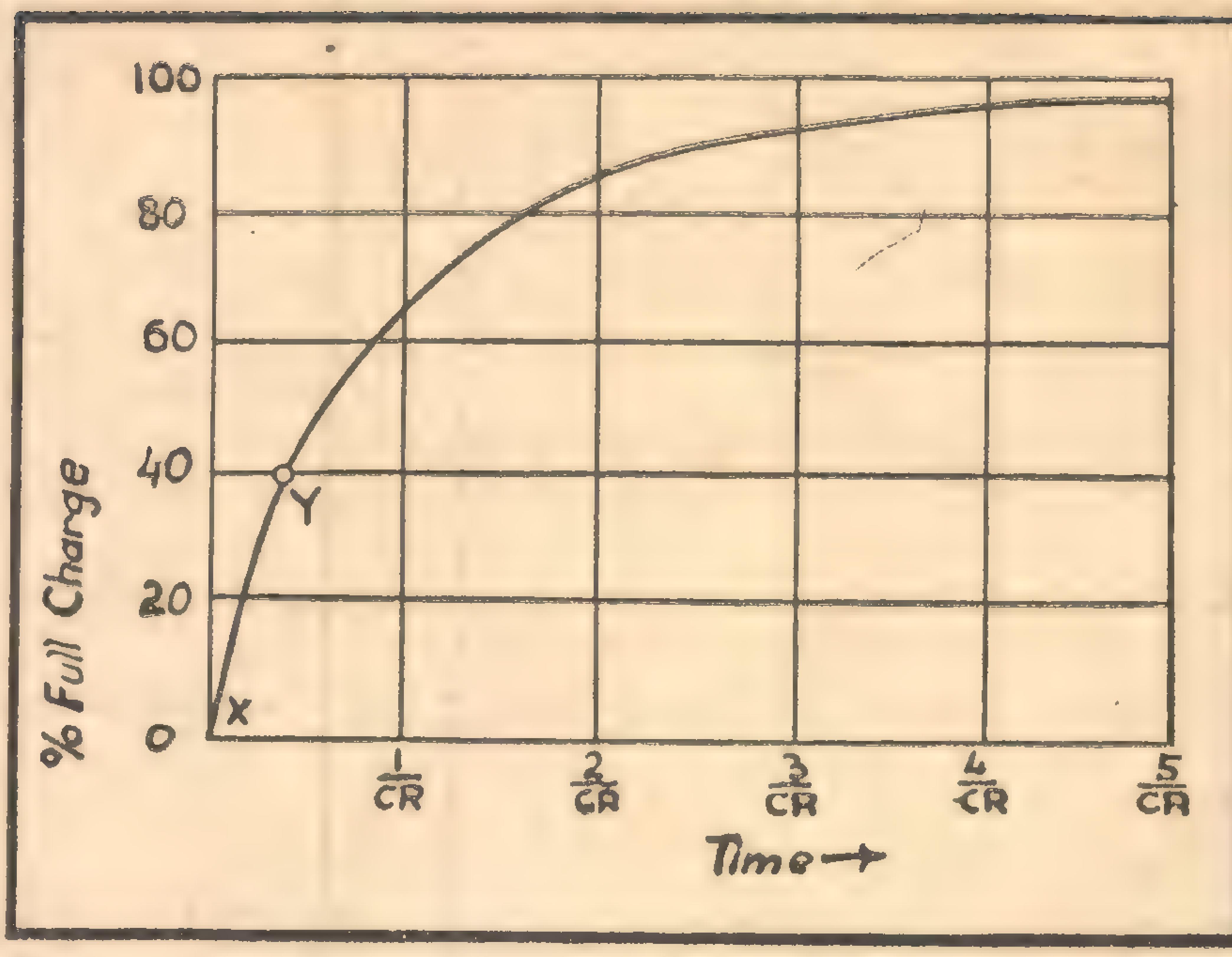


Figure 10. When a condenser, in series with a resistance, is connected across a potential, the condenser takes a certain amount of time to charge up to the full value of the applied potential. In this curve the voltage across the condenser is plotted against time. It is seen that the relationship between the two is more or less linear between zero and 40 per cent. full charge. After that the curve departs noticeably from the linear relationship.

a certain voltage is applied across the terminals. As soon as this critical voltage is reached, however, the gas within the tube ionises and the tube "lights up."

Initially, the internal resistance of a neon tube is extremely high, but, as soon as the gas is ionised, the internal resistance is reduced to a very low figure.

IGNITION AND EXTINGUISHING VOLTAGE

If now the voltage between the electrodes is gradually reduced again, it is found that the glow does not immediately disappear, but remains until, at a very much lower voltage, it suddenly disappears.

To light the lamp again, we have to come back to the first voltage. So we find two definite potentials; one may conveniently be called the "ignition" voltage, the other the "extinguishing" voltage.

If we connect our neon lamp across the condenser, we have an arrangement capable of generating a wave just as we want it.

The condenser will charge, until it reaches the ignition potential of the tube. Then the tube will begin to conduct and, as the resistance is very low, the condenser will discharge rapidly until the tube ceases to conduct. Immediately the condenser commences to charge again, and so the process goes on.

CONDENSER AND SERIES RESISTANCE

To this extent the grid controlled gas tube resembles the neon tube. However, there is an important difference. Before we discuss it, it may be well to digress for a moment to consider the charging of a condenser through a series resistor.

To get an idea how such a condenser charges up, have a look at Fig. 10. Time is plotted on the X-axis and the percentage charge is plotted on the Y-axis.

It will be seen that the charging current is approximately linear between 0 and 40 per cent. Beyond this, the curve departs noticeably from a straight line and is accordingly useless for our purpose, since time and voltage can no longer be considered as a linear function.

As a result, we have to adjust the discharge device so as to discharge the condenser at this point on the curve. The next diagram shows the process of the oscillation. The voltage rises to point Y, but as soon as it reaches this value the condenser is discharged and the potential across it returns to zero or thereabouts.

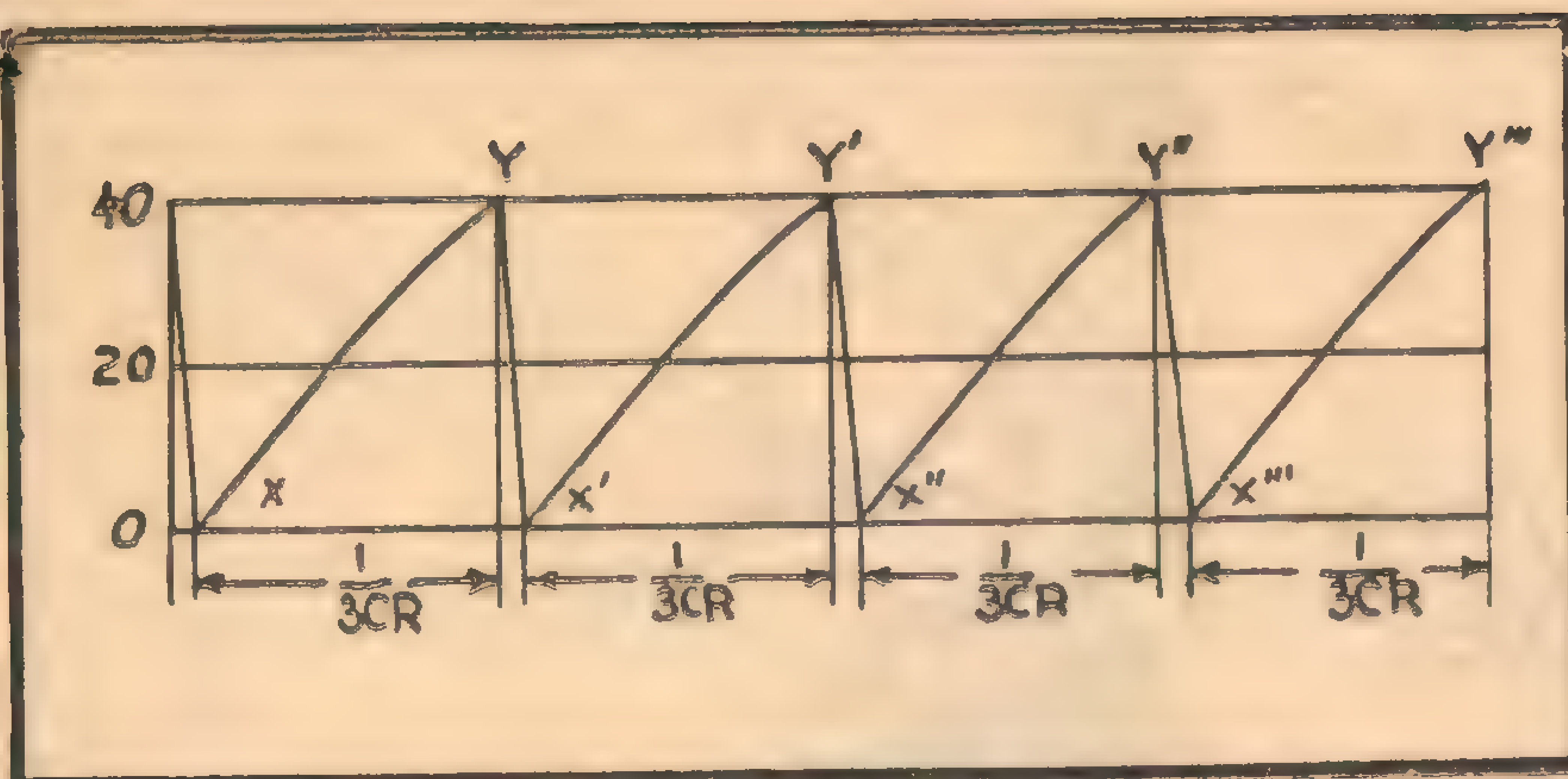
ENTHUSIASTS are often puzzled by the multiplicity of terms used in connection with cathode-ray oscillographs.

The tube itself, around which the apparatus is built, is known as the "cathode-ray tube."

The complete instrument is usually referred to as a "cathode-ray oscillograph." However, it is often called a "cathode-ray oscilloscope." Abbreviations are "oscillograph," "oscilloscope," or even "scope."

Terms synonymous with "sweep oscillator" are "sweep circuit oscillator," "sawtooth oscillator," or "time-base."

The terms "hard time-base" and "soft time-base" have already been explained in the text.



The output from the sweep oscillator is as shown in the above diagram. The charging time of the condenser is represented by the period 1/3CR and the lines XY, X'Y', &c. The discharge or "fly-back" time is represented by the small periods between the successive charging cycles.

DISCHARGE TIME

The discharge time should be as brief as possible and only a small fraction of the charging time. To rise to the value Y, the potential takes a time one-third CR, C being the capacity of the condenser in microfarads and R the resistance in megohms.

If the output from the time base does not appear to be linear, it is generally an indication that the discharge is taking place too late. This is largely a matter of correct adjustment.

For exacting work it is possible to devise more complicated circuits to give a more nearly perfect saw-tooth wave worm, but such circuits are not warranted for ordinary work.

The time base as shown proved eminently satisfactory for all frequencies above about 100 cycles per second. At 25 cycles per second the waves at one end are just slightly compressed, a disadvantage that is scarcely worth worrying about.

EFFECT OF GRID

We can now resume the previous discussion. In grid-controlled gas tubes there is a grid between the cathode and the anode. This grid makes it possible to choose the voltage at which the tube commences to conduct.

The higher the negative bias, the higher will be the necessary voltage to ionise the gas in the tube. Furthermore, by using a hot cathode instead of the usual cold cathode in neon tubes, the de-ionisation voltage can be made extremely low (10-20 volts), which is impossible with the normal neon tube.

The tube used in our oscillograph is the 885, but it is advisable to use the 884, which is exactly the same type, only having a 6.3 volt heater instead of 2.5 volts. Type 884 was not available at the time, so we had to use the 885. The most convenient type will depend on the filament windings available.

SWEEP ADJUSTMENT

To vary the speed of the time base, the condenser "C" in Fig. 9 is replaced by a number of condensers, which can be brought into the circuit by means of the switch S3. The higher the capacity the lower the sweep-frequency.

This only gives a coarse adjustment of the frequency; to make the fine adjustments to synchronise the sweep to the frequency of the signal under observation, a fine adjustment control is provided. It is simply a variable resistance in series with the condenser. The greater the resistance, the lower the frequency.

This time base voltage is fed through a divider network to the grid of the voltage amplifier for the horizontal plates. The network consists of a resistance in series with the input potentiometer.

It will most probably be found that, with the constants given, there is plenty of sweep voltage, and, with the control full on, we can just overload this amplifier.

SYNCHRONISATION

As mentioned earlier, if we make the grid of the thyratron more negative, the voltage required to ionise the tube will be higher, and, on the contrary, if we make it less negative, the tube will discharge the condenser earlier.

This effect can be used to synchronise the sweep voltage to the signal under observation. If we introduce a small amount of the signal to the grid and the two are in step, the effect will be nil.

But if, for instance, the sweep voltage is slightly too slow, then each time the condenser comes near to the discharge point the grid of the tube will be made a little amount less negative, so causing the tube to ionise earlier and to start with the new cycle at the same time as the signal.

MULTIPLE FREQUENCIES

It is possible to synchronise the time base to the original frequency of the signal or to any sub-multiple, but not to any multiple or any complicated ratio of frequencies. Thus, by experimenting with a signal frequency of 100 cycles, we can adjust and synchronise our time base to 25, 50, and 100 cycles, but not to 200, 400, or any other multiple frequency.

In an article to follow we shall try to depict some of the patterns obtained on the screen by several time base frequencies with a constant frequency on the vertical plates.

We now have gone through the constituent parts of a cathode-ray oscillograph, and the complete circuit should not be difficult to follow. It is only the logical building together of the five major parts: Power supply, CR tube, sweep oscillator, horizontal and vertical deflecting amplifiers and spot-shift controls.

In the next issue you will find complete instructions for building an oscillograph, with lay-out diagrams and photos., as well as an explanation of some minor features, which had to be omitted from this issue due to lack of space.

NEXT MONTH

Next month, we plan to describe in detail the construction of the two-inch cathode-ray oscillograph, around which this article has been written. Even if circumstances do not permit proceeding immediately with the construction of this useful instrument, the articles can be kept by until such times as they are needed.

CORRECT ANSWERS

Here are the answers to the problems on page 17.

1. .2 amp or 200 milliamps.
2. 10 volts.
3. .05 milliamp or 50 microamps.
4. 5000 ohms.

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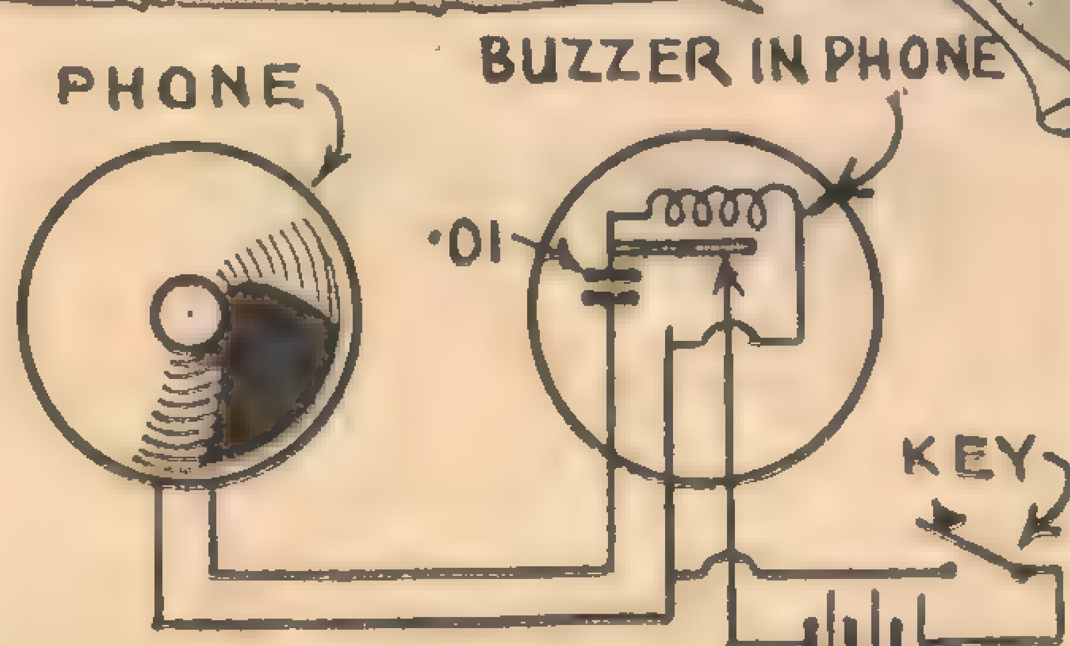
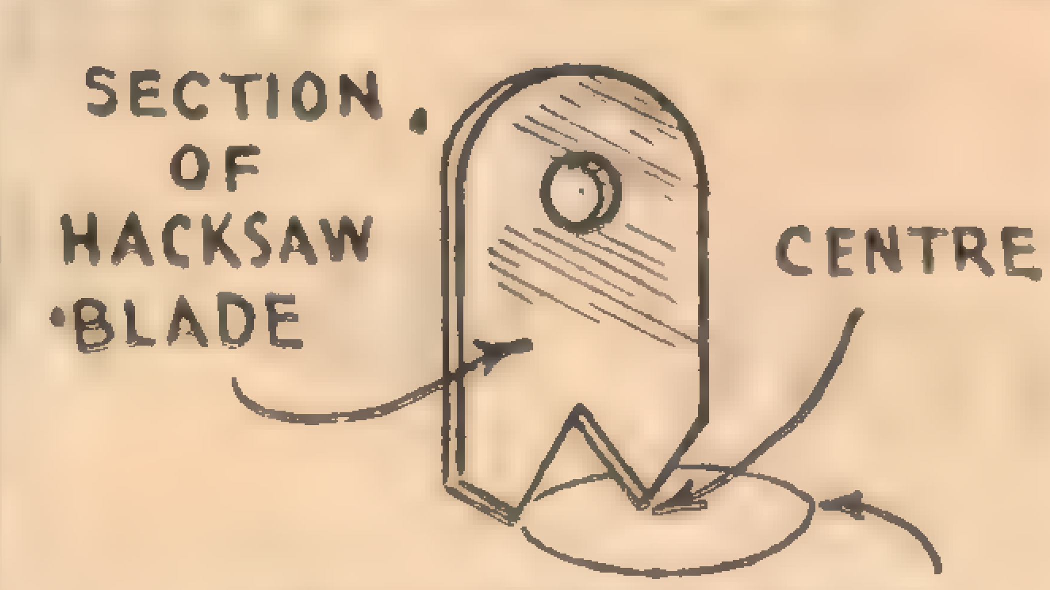


CODE PRACTICE SET

A pair of earphones, having the inside of one earpiece removed and replaced with a buzzer and wired as shown above will allow code to be practised without noise or interference to others in the same room.



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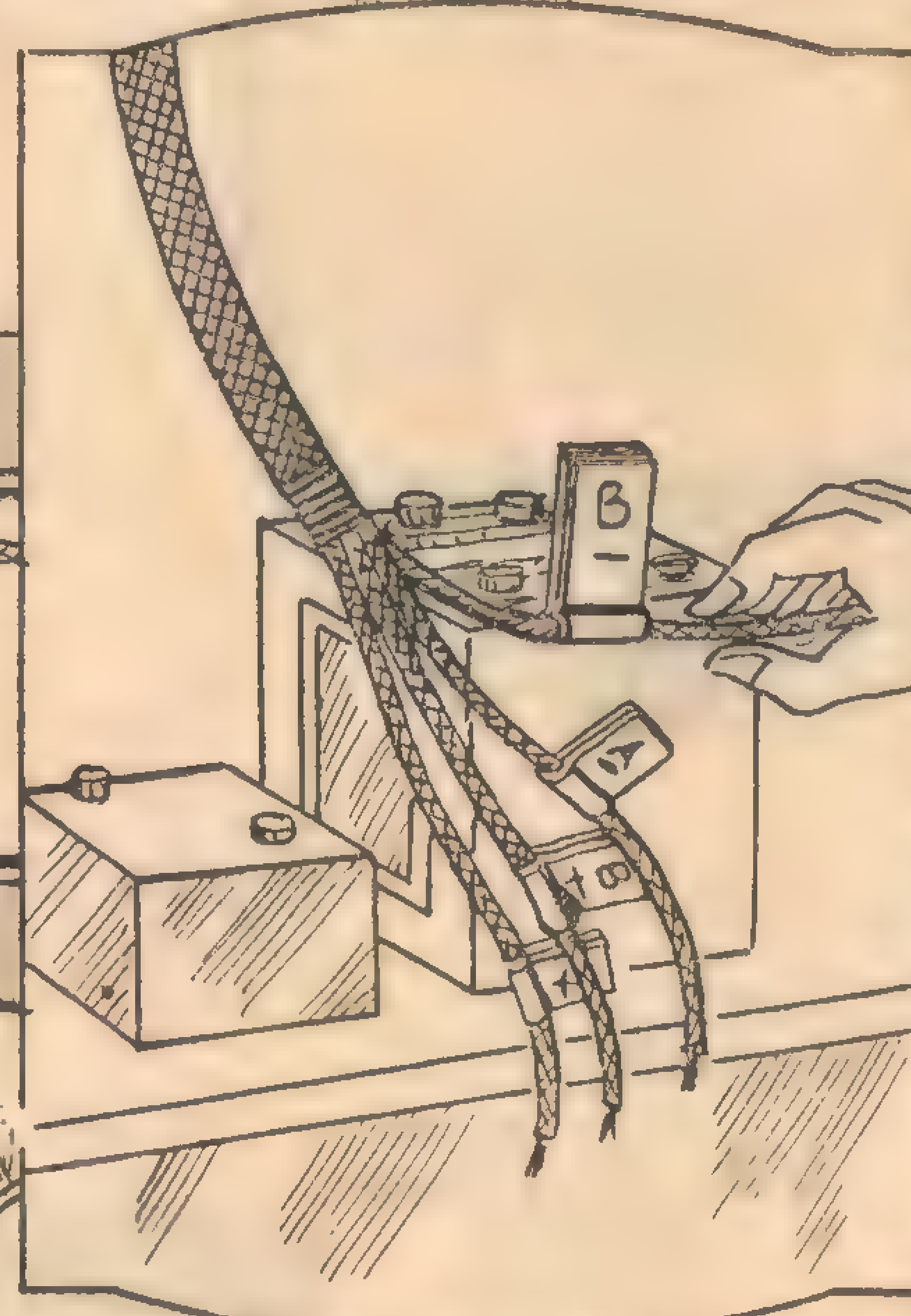
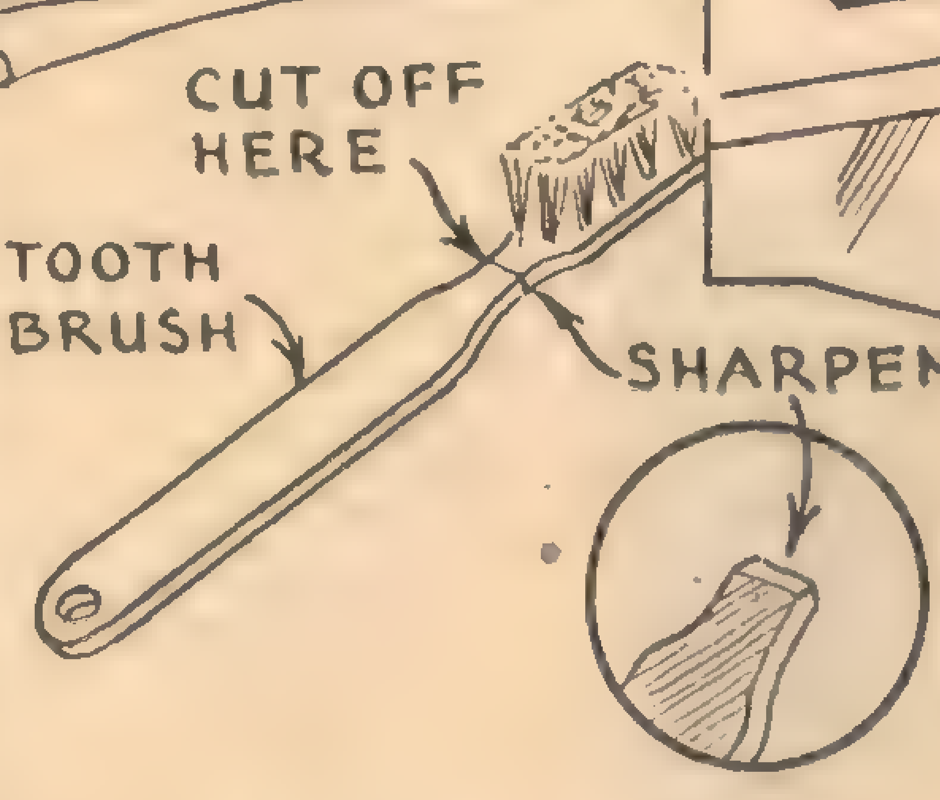
From $1\frac{1}{4}$in. wide hacksaw blades, cut into sections and ground to the shape shown above, circle scribers can be made which will scribe circles up to $2\frac{1}{2}$ inches in diameter. Keep the points sharp and accurate.



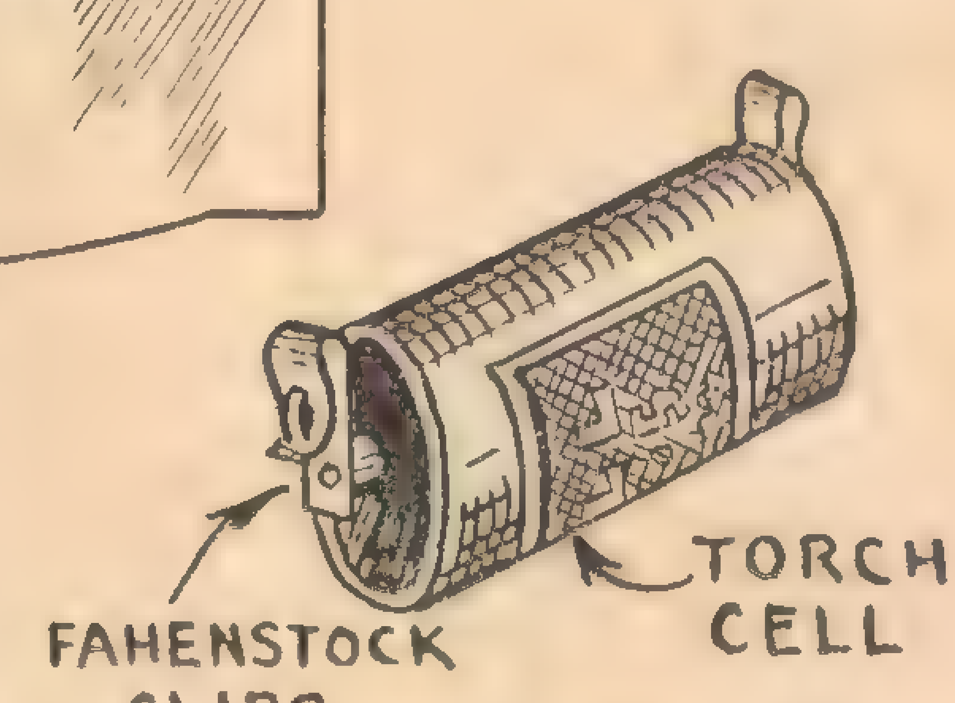
WIRE LABELS

To label various wires from a cable for easy identification, stick small lengths of adhesive tape around the wire and write the identifying mark on the tape with Indian ink.



ADJUSTING TOOL

A very handy adjusting tool for lining up intermediates, trimmers, &c., is easily made by cutting off the handle of an old tooth brush, as shown, and filing to a screw-driver point.



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Round torch cells are awkward things to connect wires to when making tests on your bench. By soldering a fahenstock clip to each contact on the cell, as shown in sketch, the difficulty is overcome for the life of the cell.

I always thought.

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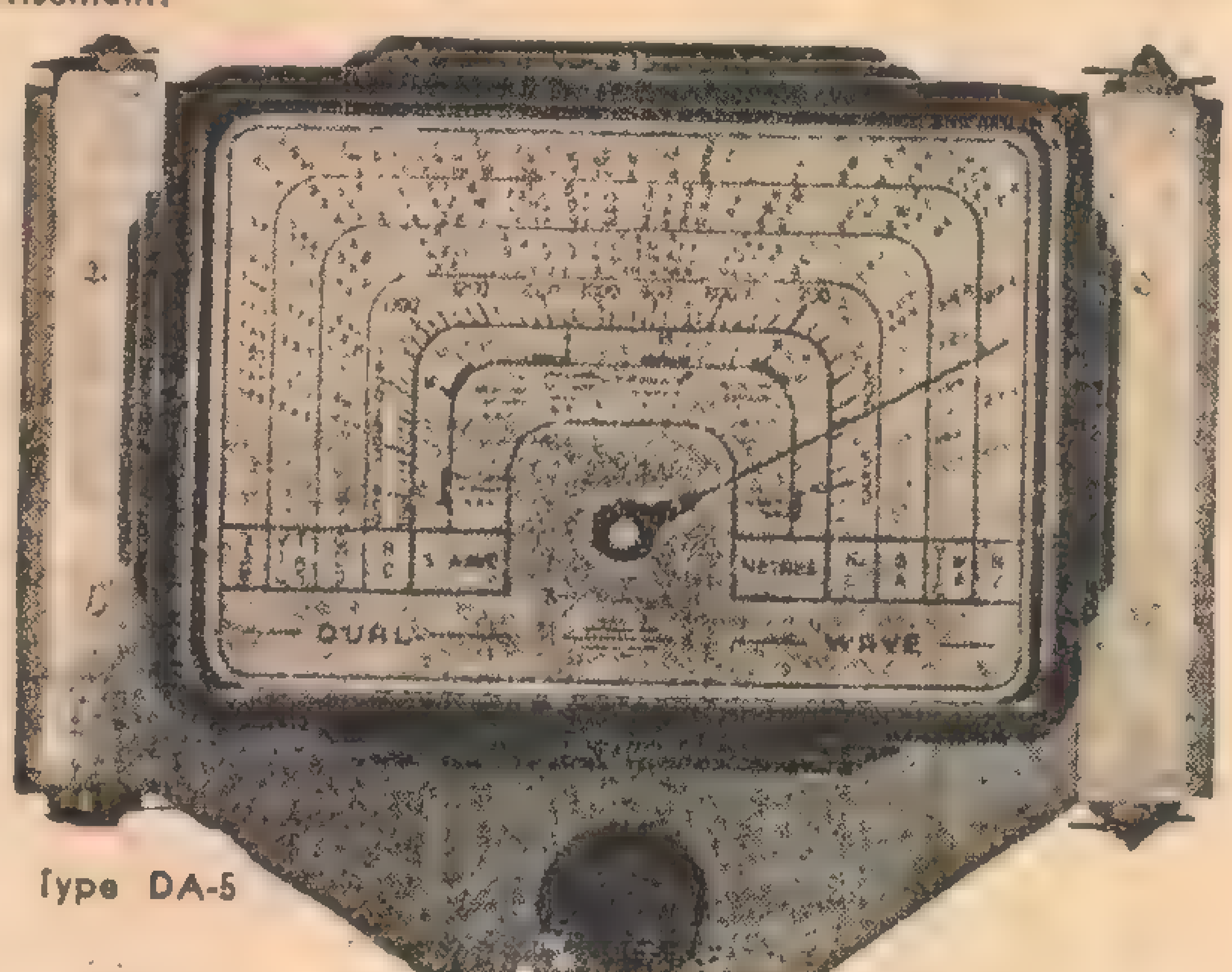

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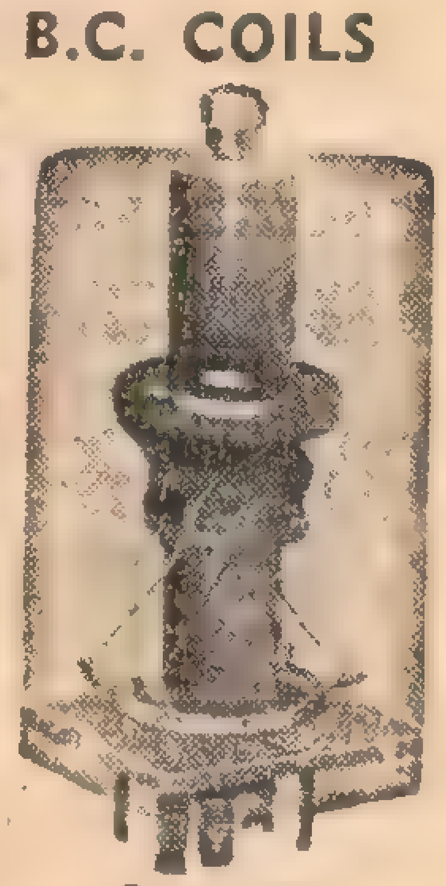

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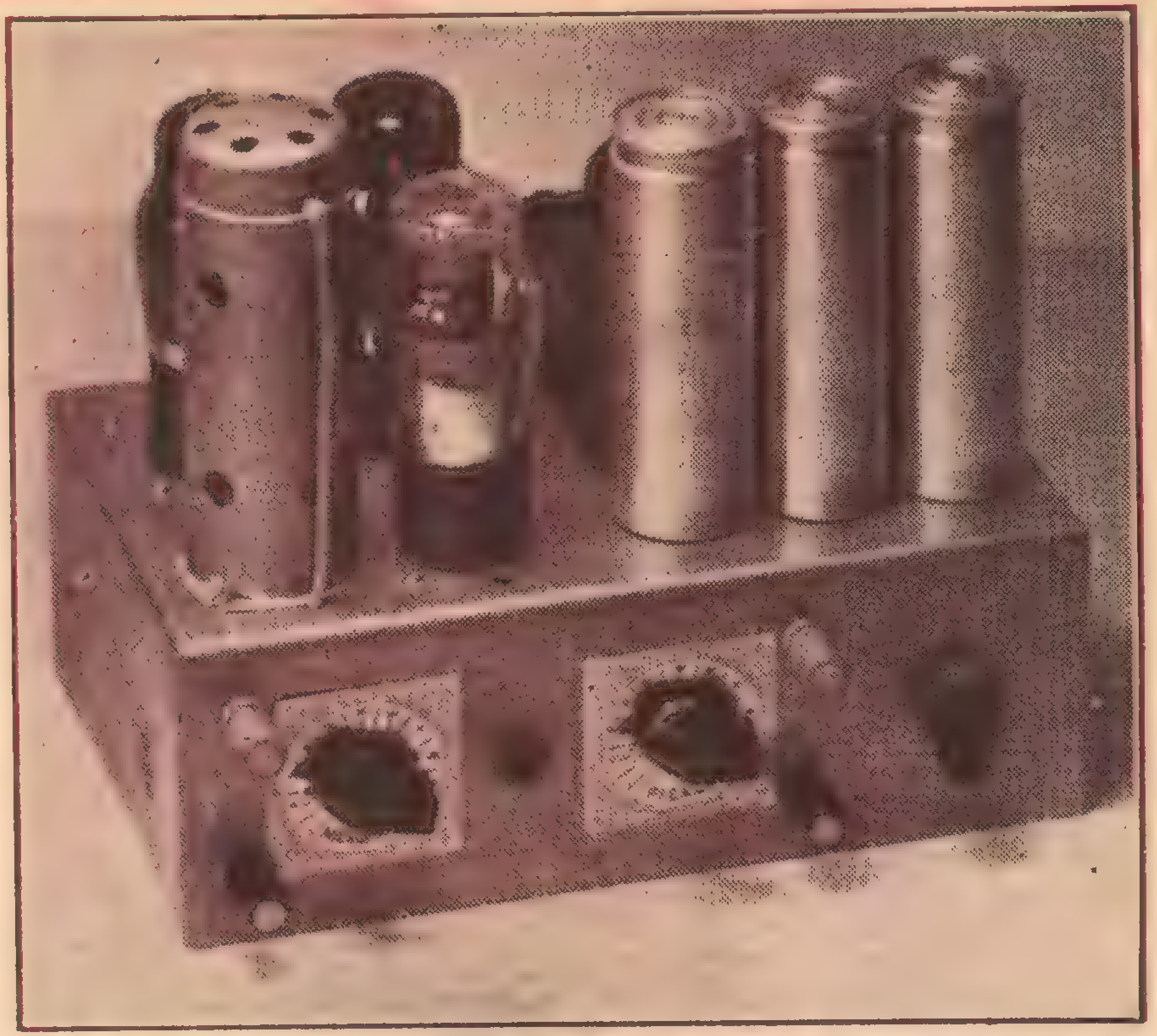
NOVEL TEN WATT AMPLIFIER FOR P.A.

Radio & Hobbies Circuit PA-3

In the first of the present series of Public Address articles, we described in detail the construction of two five watt amplifiers suitable for use at parties or at other small functions. Last month we presented a theoretical article dealing with loudspeaker networks and output transformers. Here is the third article. This time we describe a rather novel push-pull amplifier, which can be built economically and on a small chassis.



Here is the completed push-pull amplifier, built up on the small chassis originally used for the amplifiers PA-1 and PA-2. The microphone input terminals and volume control are on the extreme left of the chassis. Next comes the changeover switch, the pick-up terminals and volume control and finally the tone control.

YOU will remember that, when we described the previous amplifiers PA-1 and PA-2, we used a chassis having one more than the necessary number of valve holes. Although one does not like to see vacant holes in a chassis, we had in mind to describe other amplifiers using the same chassis and making good use of the extra valve socket hole.

One scheme which suggested itself was to use the extra hole for a preamplifier stage. No doubt many of our readers have already done this. When space permits, we intend to describe a five-watt amplifier complete with a preamplifier stage and a rather novel mixing arrangement, which we have in mind.

PUSH-PULL AMPLIFIERS

However, we did not consider it wise to describe another five-watt amplifier so soon and attention was accordingly directed to the possibility of constructing, on the particular chassis, a push-pull amplifier, which would naturally have a higher power output.

As it turned out, the idea proved quite practicable.

In the design of the amplifier the fact was borne in mind that many of our readers may have built up the amplifier PA-2, described in the February issue, and may desire to rebuild it to the push-pull circuit.

Accordingly, we sought to arrange matters so that the new amplifier would use a 100 milliamp power transformer, a 5Y3-G rectifier valve, and a loud speaker with a 1000 ohm field winding.

Owing to the fact that there was only room on the chassis for four valves in all, it was not possible to utilise the usual push-pull circuit, which requires five valves in all. If we were to have push-pull output, a totally different circuit would have to be evolved.

TECHNICAL ASPECTS

However, we have said quite enough by way of introduction and it remains to consider the technical aspects of the matter.

In any push-pull amplifier the two output valves have to be fed with signal voltages equal in amplitude, but opposite in phase.

In practise, it is seldom convenient to have the amplifier push-pull throughout, and it is preferable for the amplifier to be capable of operating from a "single-sided" input source. This obviously necessitates a special circuit arrangement in the amplifier itself to develop push-pull signal voltages for the output valves.

by W. N. Williams

One of the earliest methods of achieving this was to use a push-pull audio transformer in the plate circuit of the penultimate amplifier stage. The plate of this amplifier is fed through the primary winding of the transformer in the usual manner, and equal and out-of-phase voltages are developed across the split or centre-tapped secondary winding.

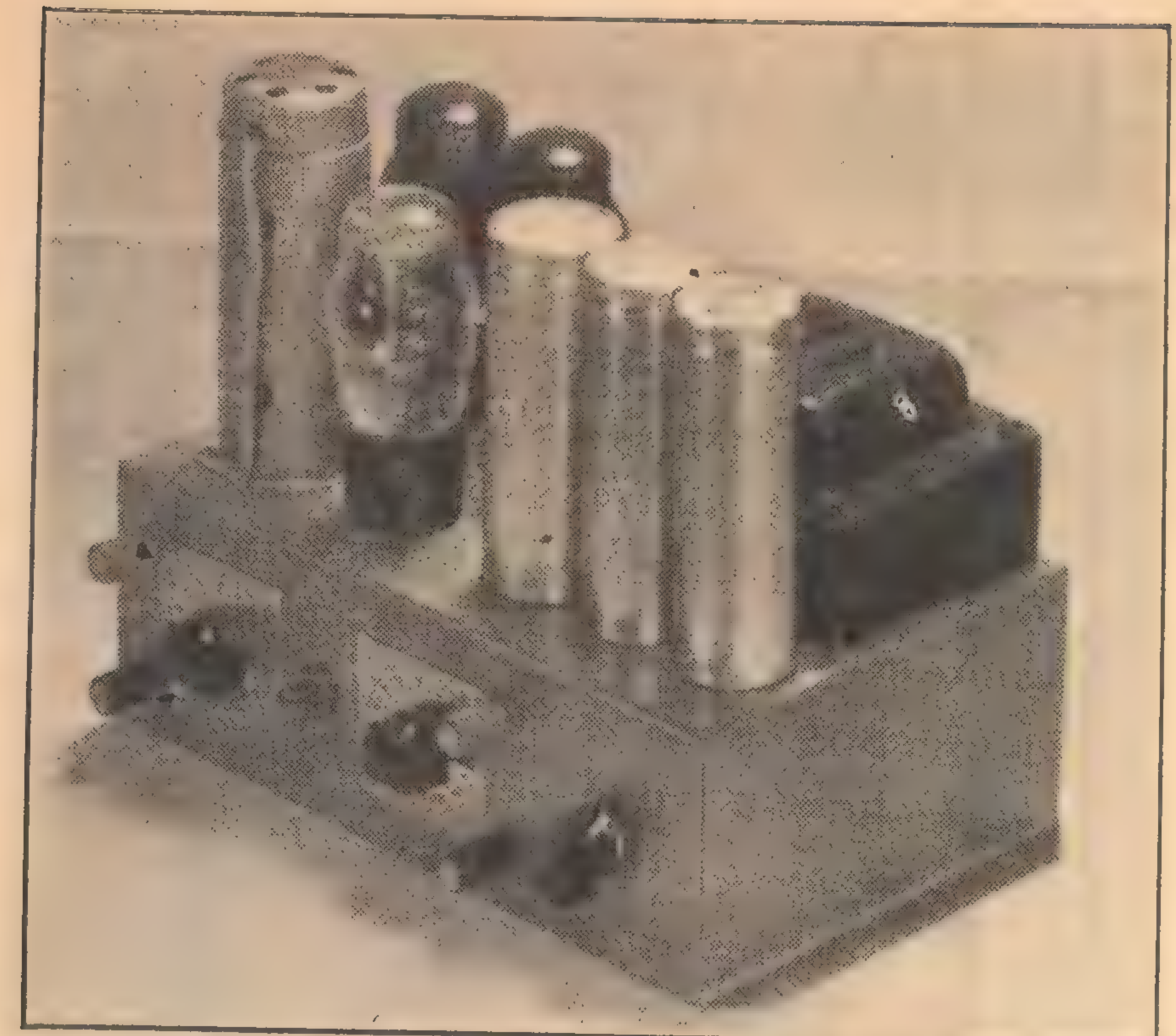
When resistance coupling became popular, special resistance coupled circuits were evolved. Chief among these were the phase-inverter and the phase-splitter circuits.

PHASE-INVERTER AND PHASE-SPLITTER

The phase-inverter is simply a special additional stage, which is included for the express purpose of developing an out-of-phase signal voltage for one of the push-pull valves.

In the case of a phase-splitter, on the other hand, a triode valve is operated with equal loads in the plate and cathode circuits. Across these two loads equal but out-of-phase signal voltages are developed. This particular circuit has been used a number of times in amplifiers described in "Radio and Hobbies."

Under ordinary circumstances the



Another view of the chassis. The 6J7-G voltage amplifier is located as far as possible from the power transformer. Alongside it is the 5Y3-G rectifier. The two output valves are side by side at the rear of the chassis. We were fortunate enough to be able to obtain can type electrolytic condensers, which improved the appearance of the amplifier and helped to avoid undue congestion beneath the chassis.

phase-splitter does not contribute materially to the overall gain and it has to be preceded by a high gain audio voltage amplifier stage.

If you want to refresh your memory on the details of this circuit, have a look at the 13 watt amplifier on page 39 of the Christmas issue. Note that the second 6J7-G is connected as a triode and has a high resistance load both in the plate and the cathode circuits. The first 6J7-G operates as a high gain pentode audio voltage amplifier.

A DISADVANTAGE

The disadvantage of all the schemes mentioned is that they necessitate the use of an additional major component —either a bulky and expensive audio transformer or an extra stage.

On the small chassis in question, it is not a proposition to use either an audio transformer or an additional stage.

Actually, there is more to it than simply trying to use a certain small chassis. At the moment, radio parts are becoming more and more scarce, and there is a real point in economising in parts, and particularly valves. Furthermore, there is always a call for an amplifier with a fairly high output and capable of being built up on a small chassis.

ANOTHER CIRCUIT

With this thought in mind, we set about to evolve a reliable push-pull circuit using the minimum number of valves. The idea of using multiple valves had to be discarded, because such valves are not made in Australia and are therefore difficult to procure.

However, to continue: It is a well-known fact that, in an ordinary amplifier stage, the plate voltage is approximately 180 degrees out-of-phase with the grid voltage. The word "approximately" is used advisedly, since the effect of any capacitance or inductance in circuit may be to cause a certain amount of phase rotation.

It follows, therefore, that, if the grid of one of a pair of push-pull output valves is fed in the normal manner, the signal voltage for the second could be obtained from the anode circuit of the first. All that would be necessary would be to use a suitable network to isolate the d-c component and to pass on the correct signal voltage.

Readers will remember that this scheme was actually used in one of our receivers some time ago, and many readers sent in enthusiastic reports about the results they obtained with it.

LOAD CRITICAL

However, the scheme has certain disadvantages which do not make it entirely suitable for a general purpose amplifier. Most serious of these is the fact that the signal voltage for the second valve is dependent on the output load impedance and variations of the latter, accidental or otherwise, cause variations in the signal voltage to the lower output valve, and consequently upset the balance of the amplifier.

For example, if the load impedance is ever made higher than it should be, the second or lower output valve will receive more signal voltage than the first, and will overload before it. If the load resistance is made too low, the effect is just the opposite.

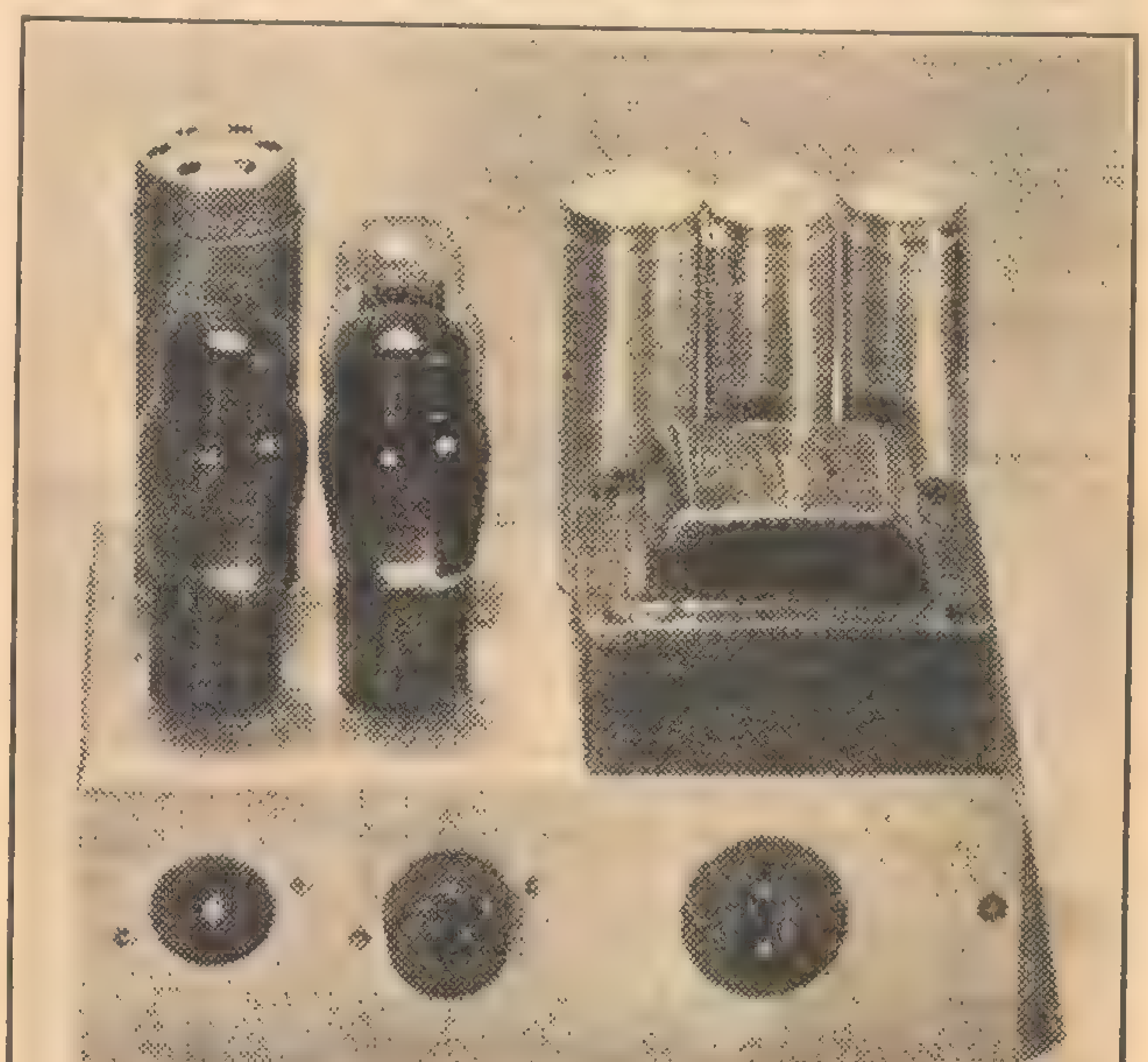
Certainly negative feedback helps in this respect, since it tends to keep the output voltage constant, irrespective of variations in the load impedance. However, it is by no means a cure-all for the trouble.

PHASE ROTATION

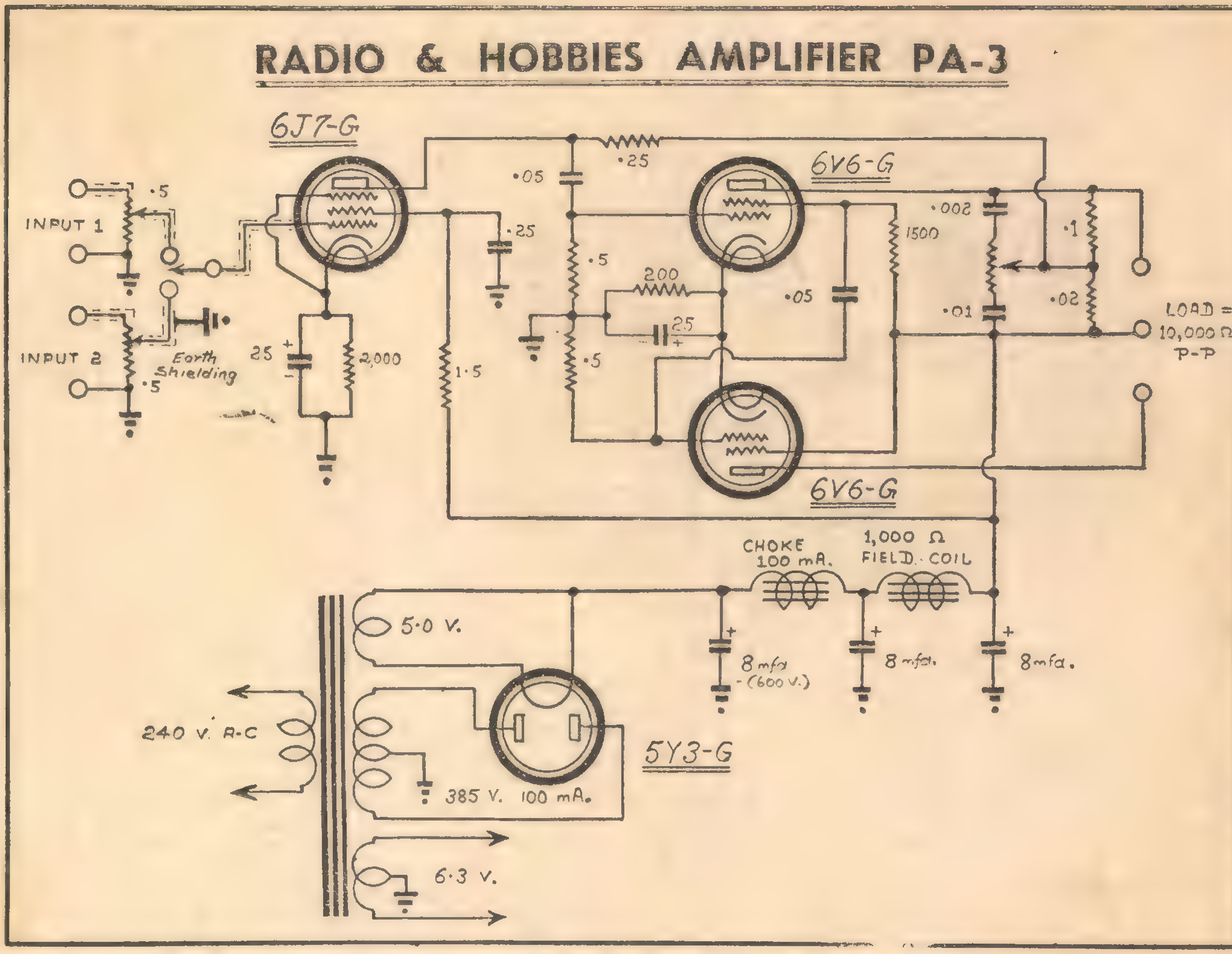
Another point, about which we were suspicious, was the matter of phase rotation, which might cause trouble when tone compensation was applied.

These matters were duly checked in a practical set-up and the troubles anticipated were actually experienced. It was found that the circuit worked well under proper conditions, but, with incorrect values of output load resistance or with tone compensation applied, the amplifier was inclined to be unstable.

At the rear of the chassis there is the five-pin loudspeaker socket, the power outlet socket and the mains plug. The power transformer shown is a 100 mA. type. A heavier transformer could be used if one is on hand. Even an 80 milliamp transformer would probably serve, although it would be operating under full load.



COMPLETE SCHEMATIC CIRCUIT DIAGRAM



The complete schematic circuit diagram. The unusual features are the method of feeding the lower output valve and the system of tone control utilising negative feedback. As the circuit stands, the output is about ten watts but higher power output could be obtained by increasing the voltage on the output valves. The tone control potentiometer is .25 meg.

This should not be construed to mean that the circuit is not capable of giving good results. It simply means that it is not an ideal circuit to use in a general-purpose amplifier, which may occasionally have to operate under makeshift conditions.

Accordingly, some other scheme was sought, which would not be subject to these troubles. The best solution appears to be to derive the necessary out-of-phase voltage from the screen circuit of the upper valve instead of from the plate circuit.

LOAD RESISTANCE IN SCREEN CIRCUIT

When the potential on the grid of an ordinary output valve is varied, the plate current and the screen rrent vary in the same direction. Thu when the grid voltage is swung in a p tive direction, the plate current rises nd the screen current also rises.

If a load resistor is c nected in series with the screen circı the variations in screen current set p variations in voltage across it. T se are in phase with the simultane s variations in plate voltage and consequently out of phase with the signal voltage on the control grid.

The relationship between the screen current and/or voltage and the grid voltage is reasonably linear and the audio voltages developed across the load resistance in the screen circuit are a replica of the signal voltages fed to the control grid.

If the value of the screen load resistor is suitably adjusted, the audio voltages developed across it can be made exactly equal to the signal voltages on the grid but, of course, 180 degrees out of phase. These voltages may then be fed to the grid of the lower output valve through a suitable coupling network.

This scheme is by no means original

AMPLIFIER PARTS LIST

1 Chassis, 9½ x 6 x 3¼.
1 Power transformer 385v CT., 385v HT. at 100 mA., 6.3v at 3 amp., 5v at 3 amp.
1 Filter choke, 100 mA.
3 8 mfd. electrolytic condensers.
2 25 mfd. electrolytic condensers.
1 .25 mfd. tubular condenser.
2 .05 mfd. tubular condensers.
1 .01 mfd. mica condenser.
1 .002 mfd mica condenser.
1 1.5 meg. resistor, 1 watt.
2 .5 meg. resistors, ½ watt.
1 .25 meg. resistor, 1 watt.
1 .1 meg. resistor, 1 watt.
1 .02 meg. resistor, 1 watt.
1 2000 ohm resistor, 1 watt.
1 1500 ohm resistor, W.W.
1 200 ohm resistor, 3 watt.
2 .5 meg. potentiometers.
1 .25 meg. potentiometer.
1 2-way switch.

SOCKETS: 1 5-pin, 1 6-pin, 4 octal.

VALVES: 1 6J7-G, 2 6V6-G, 1 5Y3-G.

SPEAKER: Electro-dynamic, with 1000 ohms field coil and plate to plate impedance of 10,000 ohms.

SUNDRIES: 4 terminals, 1 valve can, three pointer knobs, 2 indicator plates, braided wire, hook-up wire, nuts and bolts, 1 grid clip, &c.

and we have seen it used on other occasions. Some may be inclined to look upon it as a technical "wangle," but there is no need to apologise for it.

The finished amplifier performed in grand style and there was not the slightest suggestion of instability or of parasitic oscillation on peaks of signal. On an oscillograph the output wave appeared to be perfectly clean at all audio frequencies.

In our amplifier the output valves used were type 6V6-G. It was found that, under the particular operation conditions, a resistor of 1,500 ohms in the screen of the upper valve gave just the right signal voltage for the lower valve. The d-c voltage drop across the resistor was very small and we venture to say that its effect on the normal operation of the valve would be negligible.

VALUE OF SCREEN LOAD RESISTOR

It must be pointed out that the value of the screen load resistor specified is only correct for type 6V6-G valves under particular operating conditions. For other operating conditions an entirely different value may be necessary, although we cannot say, at the moment, how great the variation might be.

Similarly, for other types of output valves, different values of screen load resistance would probably be necessary.

There does not seem to be any easy way of calculating the value without an intimate knowledge of the more obscure characteristics of the particular valve. In our case the exact value was determined experimentally, the indication being obtained by means of a cathode ray oscillograph.

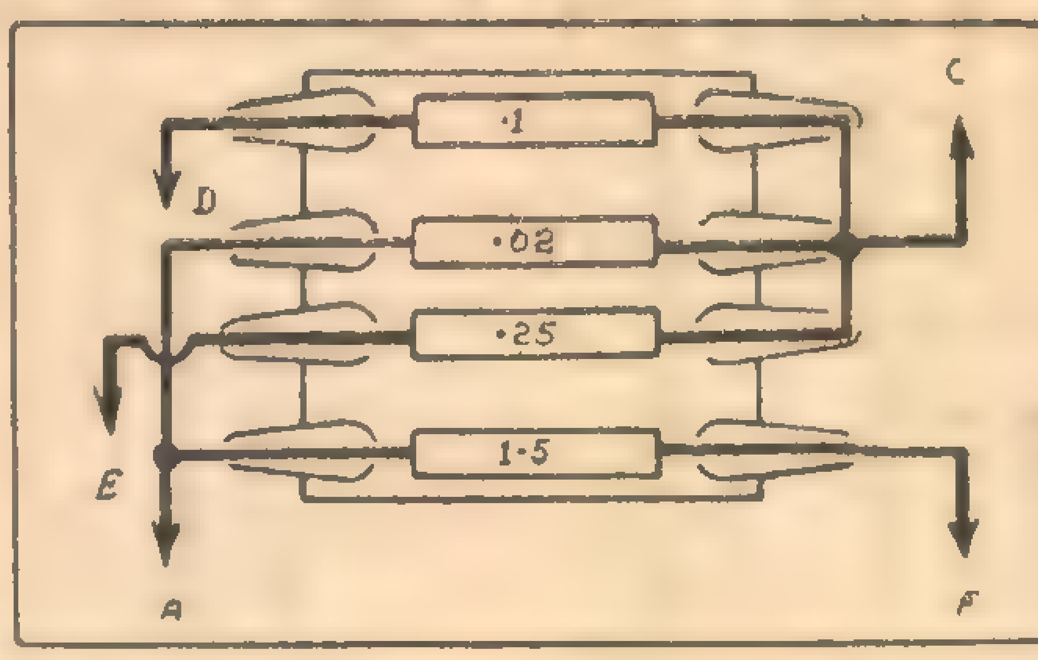
The d-c screen current of type 6V6-G valves, in common with all other beam tetrodes, varies somewhat from valve to valve and we were rather apprehensive lest this should result in considerable variation in the audio output voltage from the screen circuit of different valves.

This point was carefully checked on the oscillograph with all the valves on our shelves, but it was found that the variation from valve to valve was negligibly small.

You will note that the connection of the second output valve does not interfere, to any extent worth mentioning, with the normal operation of the voltage amplifier and the upper output valve. The overall gain is not materially affected, and it simply means that we get twice as much power output for the same power input.

If you are fussy about detail, you may connect another 1500 ohm load resistor in the screen circuit of the lower valve so that the two output valve circuits will be exactly balanced. However, we did not consider that such a resistor was necessary.

RESISTOR PANEL



There are only four resistors in all on the resistor panel. The resistors should be interconnected as shown and then wired into the amplifier according to the letter code.

NEGATIVE FEEDBACK AND TONE CONTROL

It was considered desirable to provide negative feedback, and this was ultimately applied to the plate circuit of the voltage amplifier from a divider network across the upper portion of the loudspeaker transformer. In fact, the circuit is exactly the same as for a single sided amplifier.

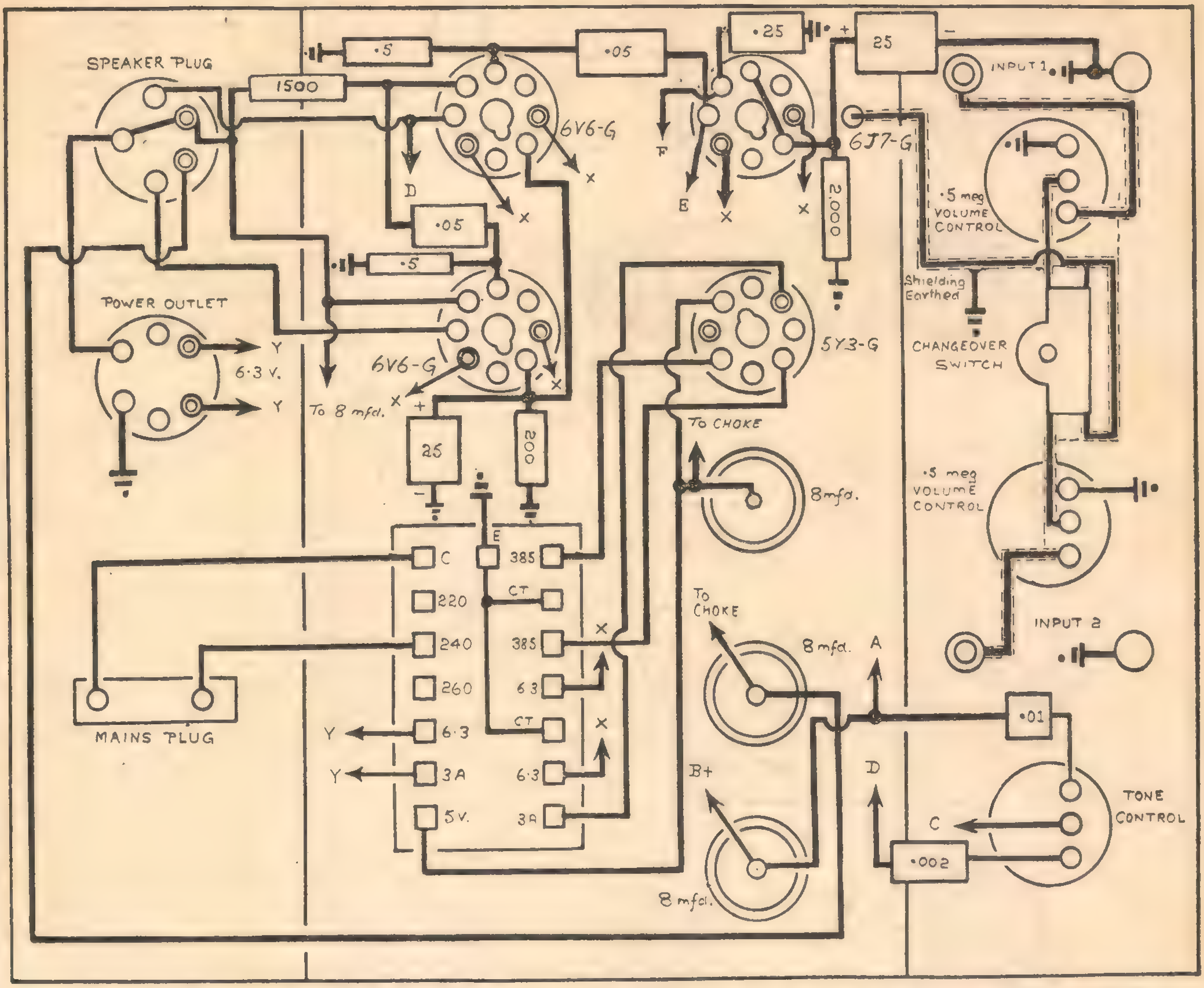
Due to the coupling between the two halves of the output transformer primary winding, the feedback is effective for both output valves. This point is not difficult to check.

The next matter considered was that of fitting a tone control. In the amplifiers PA-1 and PA-2, and in the 1942 Pentagrid Four receiver, the tone control system permitted the treble response to be either accentuated or attenuated, as desired.

In view of this, we were not contented at the thought of fitting an ordinary "top-cut" control.

Accordingly, we tried out the same tone control switch arrangements as used in the previous amplifiers PA-1

UNDERNEATH WIRING DIAGRAM



Here is the underneath wiring diagram for the amplifier. Everything is fairly clear and you should not have any difficulty in following it. The resistor panel has not been drawn in but the various connections to it are letter-coded. The diagram of the panel itself appears on the opposite page.

and PA-2. In practice, the scheme worked very well.

It follows that, if the feedback network is upset, so that the output of the upper valve at high frequencies is accentuated or attenuated, the input to the lower valve at these frequencies is changed, and its output must likewise be greater or less, as the case may be.

AVOIDING A SWITCH

Unfortunately, a few of our readers seem to have had unexpected difficulty in obtaining a suitable tone control switch. This is rather surprising, since a single-bank five-position switch is all that is required. In fact, any ordinary tapping switch could be pressed into service, provided the arm was suitably insulated.

However, to avoid further difficulties on this score, we set about to evolve a circuit which would yield the same results but without the necessity of using a switch. A few minutes' work with a pencil and a scrap of paper provided the solution. Have a look at the tone control system shown in the circuit diagram.

Across the negative feedback divider network is connected another network comprising a .002 mfd. condenser in series with a .25 megohm potentiometer in series with a .01 mfd. condenser. The moving arm of the potentiometer is returned to the junction of the two resistors comprising the feedback divider network.

RESISTOR COLOR CODE

VALUE	BODY	END	DOT
1.5 meg.	Brown	Green	Green
.5 meg.	Green	Black	Yellow
.25 meg.	Red	Green	Yellow
.1 meg.	Brown	Black	Yellow
.02 meg.	Red	Black	Orange
2000	Red	Black	Red

When the arm of the potentiometer is rotated to one extreme position, the .01 mfd. condenser is rendered ineffective, and the .002 mfd. condenser is shunted across the upper portion of the feedback divider network. This has the effect of increasing the feedback at high frequencies and naturally results in high frequency attenuation.

TREBLE CUT AND BOOST

When the control is rotated to the other extreme, the .002 mfd. condenser is rendered ineffective and the .01 mfd. condenser is connected in parallel with the lower portion of the divider network. This decreases the feedback at the higher frequencies and results in treble boost.

At intermediate settings of the control it is possible to obtain more moderate degrees of treble boost or cut, or to obtain a level response.

The capacitance of the respective condensers determines the frequency

range over which the tone control is operative, and values can be chosen to suit individual requirements. However, the values specified should be found suitable for most purposes.

To obtain smooth control, advantage must be taken of the "taper" of the resistance element. With ordinary potentiometers, the control has to be wired so that rotation in a clockwise direction results in treble attenuation. If you find that the control is not smooth, try the effect of reversing the outer connections.

WIDER APPLICATION

This type of control can quite readily be applied to conventional single-sided amplifiers, such as the amplifiers PA-1 and PA-2. With the latter amplifiers, it is simply a matter of substituting the network shown for the tone control switch and the associated condensers.

If the tone control potentiometer is fitted with an off-on switch, this can be wired so as to open circuit the connection between the entire feedback network and the plate circuit of the output valve. However, it is recommended that the feedback be left in circuit where possible.

The remainder of the circuit is more or less conventional. Two sets of input terminals are provided, the desired input channel being selected by a change-over switch.

OVERALL GAIN

Mixing circuits could be incorporated, if desired. As yet we have not been able to cover this subject in the present series of articles. For general information on mixing circuits, we suggest you refer to the article in the December issue under the heading "PRE-AMPLIFIER PROS. AND PROBLEMS."

The overall gain of the amplifier is ample to allow full output to be obtained with almost any type of gramophone pickup or with a high output carbon microphone. The gain is also sufficient to allow the amplifier to be used with a high output crystal microphone under close talking conditions.

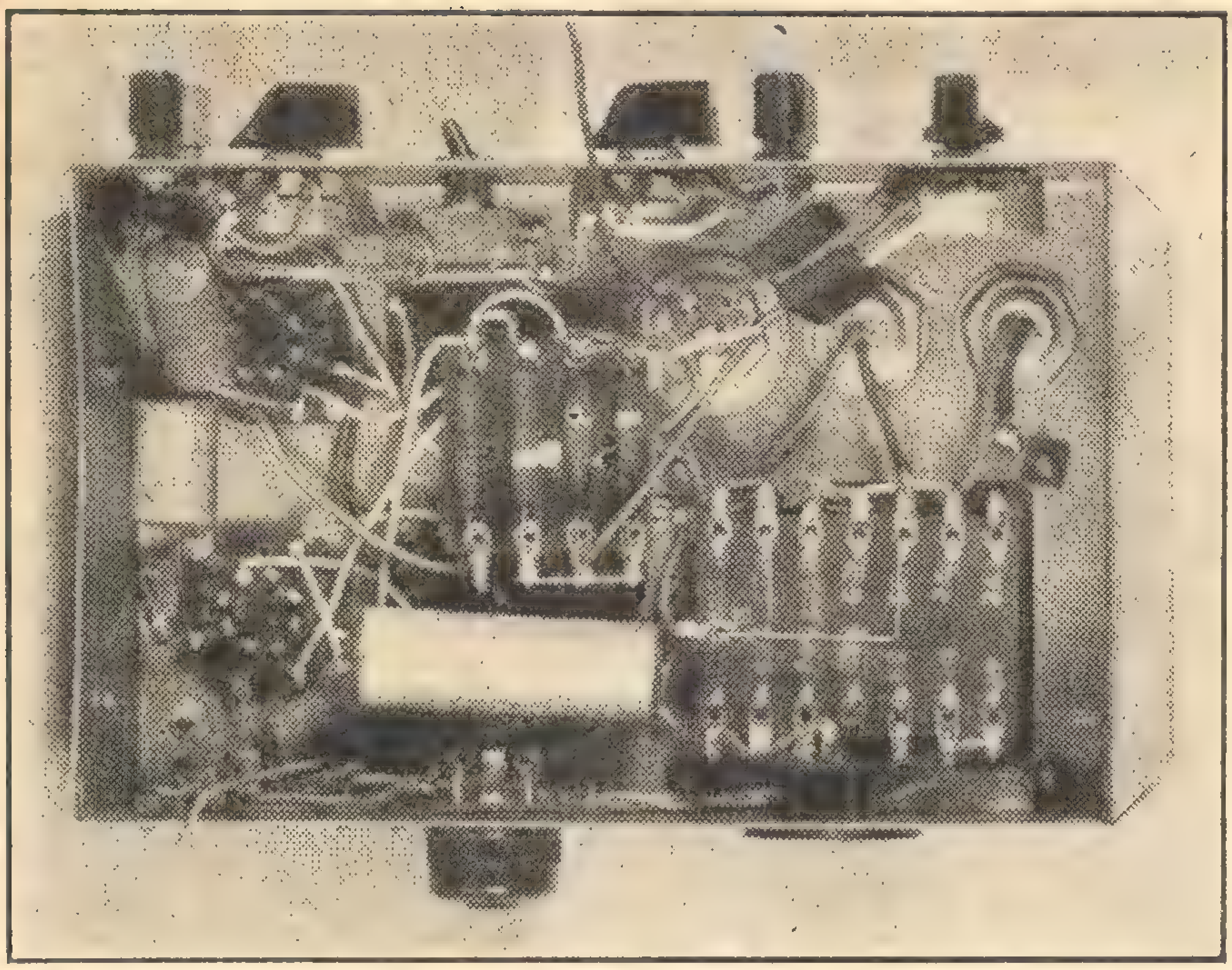
Under conditions of distant speaking or with low output microphones, a separate preamplifier stage would be necessary.

The voltage amplifier is a 6J7-G, operating as a high gain pentode and feeding into the upper output valve in the usual manner. The method of feeding the lower output valve has already been discussed in some detail.

OUTPUT VALVES

As the circuit stands, the output valves are operating under very easy conditions, and should, therefore, last quite a long time. These days, there is quite a point in making one's valves last as long as they will. Replacement valves are becoming more and more difficult to obtain, and the position may become steadily worse as the war progresses.

For all that, you will find that the amplifier will give 10 watts of output, free from any obvious distortion. We had no opportunity of taking precise measurements of the performance, but



Here is the underneath photograph, showing where all the parts fit in. The resistor panel is mounted in its correct position but the power choke has been removed for the sake of clarity. The latter mounts underneath the chassis and below one of the 6V6-G sockets. Care has to be taken to keep the parts clear of the space occupied by the choke.

the output appeared to be quite "clean" of an oscillograph.

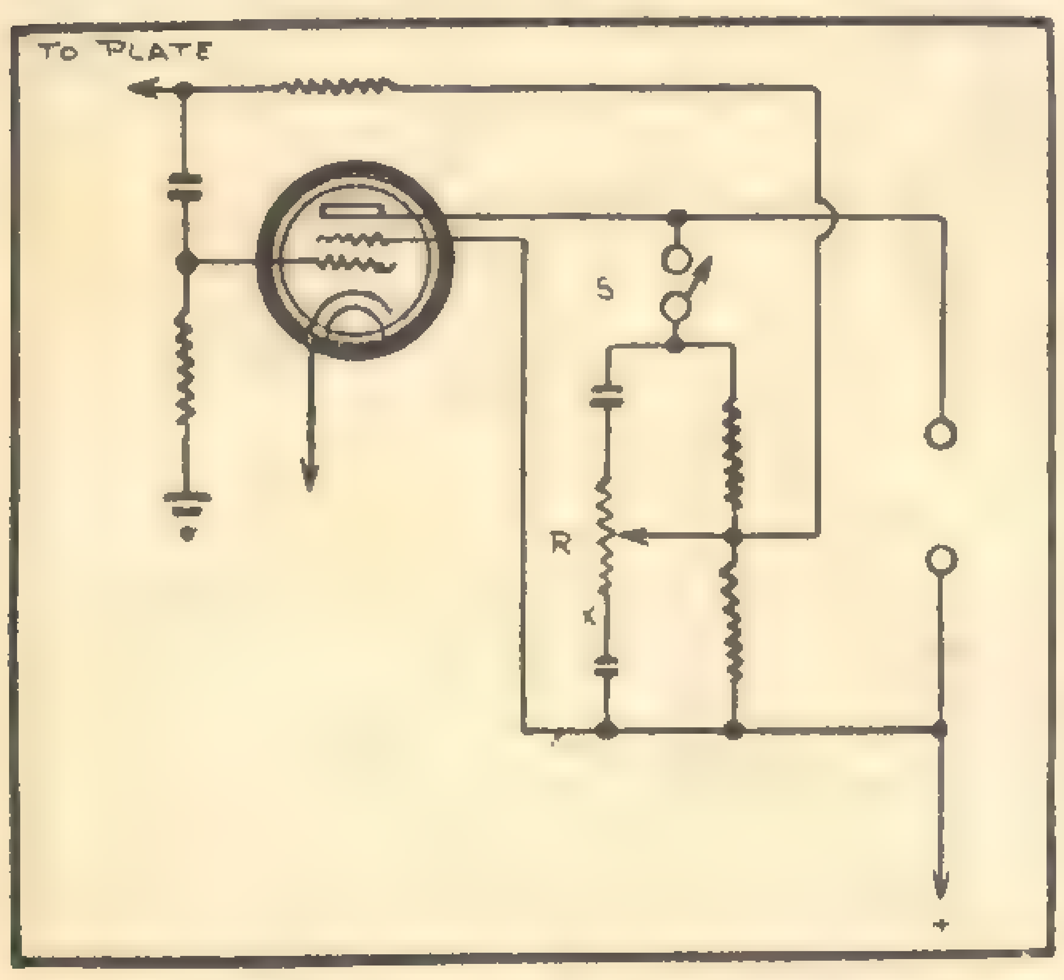
If higher output is desired, the voltages on the output valves can be pushed up, and there should be no difficulty in obtaining the 13 watts output claimed for previous amplifiers using type 6V6-G output valves.

If the operating conditions are changed considerably, it would be advisable to check the value of the screen load resistor, if facilities are available. Once set, the value should not need to be changed for individual valves of the same type.

The optimum plate-to-plate load for the output valves is 10,000 ohms, and it is advisable to adhere to this value. Slight mis-matching might not be noticeable, but excessive mis-matching would result in poor performance.

VOLTAGE and CURRENT MEASUREMENT

Total high tension voltage	270 volts
6V6-G screen to cathode	254 volts
6V6-G cathode to earth	16 volts
Voltage drop across field	77 volts
Total high tension current	77 mA.



If the volume control potentiometer R is equipped with a built-in off-on switch, the latter can be wired as shown to cut out the feedback when the control is advanced to the extreme treble boost position.

POWER SUPPLY

The power supply circuit is quite conventional. A standard 100 milliamp power transformer is specified, but a heavier transformer could be used if one is on hand. At a pinch, an 80 milliamp transformer might even be used, but it would be operating without any margin of safety.

A two-section filter is specified, comprising a 100 milliamp power choke and a 1000 ohm field coil. With this arrangement, the hum was imperceptible under ordinary circumstances. In some cases it may be found possible to do without the choke.

Ideally, the first two electrolytic condensers should be 600-volt wet types Unfortunately, there are few, if any, available nowadays and it will probably be found necessary to use semi-dry types

Can type condensers make things easier from the point of view of space, since they mount on top of the chassis. If semi-dry condensers have to be used, try and obtain 600-volt types, at least for the two condensers nearest the rectifier

TORCH LAMP FUSE

As we suggested in another article, it is often a good plan to wire a torch lamp as a fuse in series with the centre-tap connection to the high tension secondary winding of the transformer. In the event of one of the condensers becoming a short circuit, this will protect the rectifier from complete disaster. Naturally, it is necessary to use a globe having a sufficiently low fusing current.

The power supply shown would be quite capable of supplying the small additional current drain necessary to operate a preamplifier stage. However, the current drain of a tuner would be rather high and would cause undue reduction of the high tension voltage. Under these circumstances it would be desirable to use a 5V4-G rectifier valve, which would offset the additional voltage drop across the speaker field.

ASSEMBLING THE COMPONENTS

The various photographs of the chassis show clearly where all the parts fit in. The only component which will call for careful manipulation is the power choke, which fits underneath the chassis, immediately below one 6V6-G socket.

It is advisable to obtain a compact choke, as otherwise some difficulty may be experienced in getting it to fit in. There are no holes in the chassis for the choke and you will have to drill two holes to suit your particular choke.

When assembling the components on the chassis make sure to mount everything firmly and tighten the transformer bolts properly to prevent the laminations humming when the amplifier is in operation. Solder lugs should be placed here and there under mounting bolts to act as earth points.

WIRING

The entire input circuit to the first valve should be shielded to guard against electrostatic hum pick-up. The various pieces of braiding should be bonded together and definitely earthed. Make sure also to earth one of each pair of input terminals.

The earthing system for the input circuit should be kept quite separate from the earthing system to do with transformer. The screen and cathode bypass condensers and the cathode resistor of the 6J7-G should be returned to the "input" earth system and kept well away from the power transformer.

(Continued on Page 51)

AN A-C OPERATED AUDIO OSCILLATOR

(Continued from Page 15)

A rear view of the oscillator chassis. Note how the speaker fits into a cut-out in the chassis. Note also the countersunk screws in the back of the chassis which allows the latter to slide into the steel case without fouling the sides.

The outfit, as shown, only draws about 8 or 10 mA from the high-tension secondary. It is, therefore, operating very lightly loaded. The type of smoothing may be strange to some readers, but it is, in fact, quite a common type of low-current supply. A 5000-ohm resistor is used in place of a smoothing choke, and, with the two 8-mfd dry electrolytic condensers, provides an efficient filter.

BLEEDER RESISTANCE

A bleeder resistance of 50,000 ohms is used to place a steady load on the supply and help to stabilise the voltage. This bleeder may be of the carbon type rated at 2 watts. If a 50,000-ohm 2-watt type is not available, place either two 25,000-ohm 1-watt in series or two .1-meg 1-watt in parallel.

Some may have on hand a small transformer with a secondary winding rated at 250 volts per side. In this case, the transformer would be connected in the usual full-wave circuit, with the ends of the winding going to the respective rectifier plates and the centre-tap to earth.

USING STANDARD TRANSFORMERS

In order to reduce the voltage at the output of the filter, a resistor of from 3000 to 5000 ohms may be connected between the filament of the rectifier V1 and the junction of the two components R1 and C1. The exact value will vary somewhat but it should be such that the supply voltage at the output of the filter is between 200 and 250 volts.

The voltage is not at all critical, but it should preferably be within the limits mentioned.

With a 325-0-325 volt transformer, the value of R1 should be increased to 20,000 ohms (3-watt) and a resistor of 3000 ohms (3-watt) connected between the filament of the rectifier and the junction of C1 and R1.

With a 385-0-385 volt transformer, R1 remains at 20,000 ohms, but the value of the other resistor must be increased to 7500 ohms (5-watt).

In either of the latter cases, the values of condensers C1 and C2 may be reduced considerably below 8mf, although there may actually be very little point in doing this.

FILTER CHOKE

Some readers may want to use a smoothing choke instead of the resistor. This is quite in order so long as the choke is of the high-resistance variety. If it is of low resistance, as most chokes are, R1 should be left in the circuit, too.

Of course if it is convenient to do so, the required 200 or 250 volts may be obtained from an existing power supply, which may be on hand. It may even be obtained from a receiver. However, care should be taken to see that there is a large-capacity condenser between B plus and earth. If this condenser is not present in circuit, the oscillator may not function satisfactorily.

If several oscillators are to be operated in close proximity to one another, they may have a common power supply. This would need to be well regulated, so that the various oscillators would have no mutual effects. The heater leads would also need to be sufficiently heavy to avoid undue voltage drop.

PERMAGNETIC SPEAKER

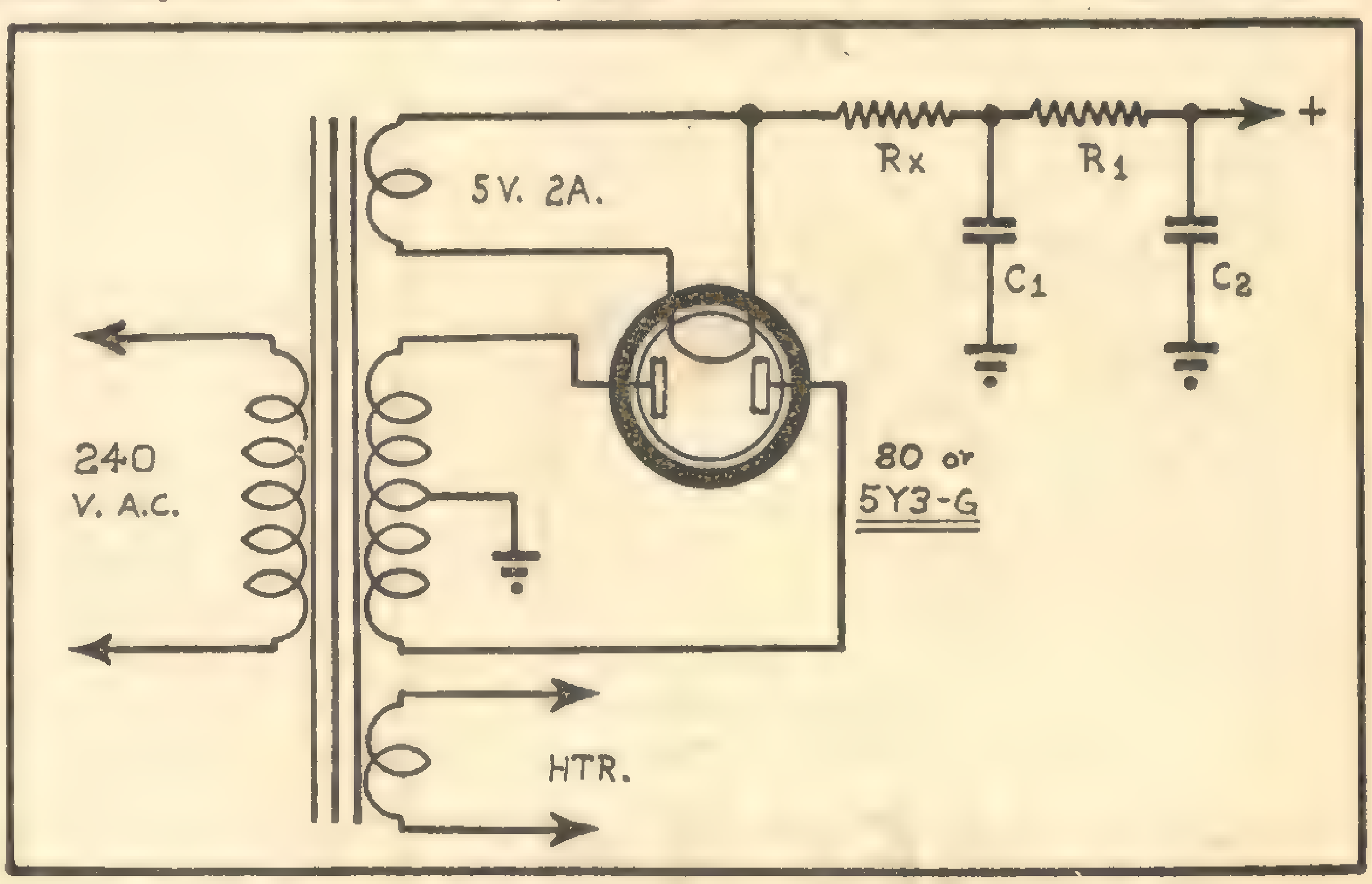
Because of its obvious convenience, the writer used a permagnetic speaker. However, an electrodynamic type may be used equally well, provided that the field is suitably energised. Furthermore, the speaker would need to be reasonably sensitive if full advantage is to be taken of the output of the oscillator.

Once again, it is scarcely practicable to give circuits covering all possible combinations of field resistances, power transformers, and rectifiers. Much must be left to the ingenuity of the individual constructors to make the best use of the parts available.

ELECTRO-DYNAMIC LOUD SPEAKERS

If the speaker to be employed has a field resistance of 5000 ohms or more, it could best be connected in shunt across the high-tension supply, the necessary smoothing being obtained with a suitable power choke and a couple of electrolytic condensers.

On the other hand, if the speaker has a resistance of 2000 or 2500 ohms, it could be used as a filter, in which case the current flowing through it



For those who want to make use of a conventional full-wave transformer, here is the modified power supply circuit. With a 250/0/250 volt transformer Rx would be from 3000 to 5000 ohms and R1 5000 ohms. With a 325/0/325 volt transformer, the respective values would be 3000 and 20,000 ohms, and with a 385/0/385 volt transformer 7500 ohms and 20,000 ohms.

The simplicity of the underneath wiring is apparent from this photograph. We have not attempted to give an underneath wiring diagram, since it would only be of use to those who duplicated exactly the original oscillator. However, it should not be a difficult matter for anyone with the slightest technical knowledge to get things right.

would have to be increased by including heavy bleed resistance between B plus and earth.

The latter scheme would only be practicable where the power transformer had a fairly high secondary voltage. It would not be satisfactory with the 200-volt transformer shown in the original circuit.

GENERAL REMARKS

The general idea is to arrange matters so that the field is sufficiently energised and so that there is an effective plate-supply voltage of about 200 volts. The voltage should preferably not be more than 250 volts or less than about 175 volts. If it is too low, the oscillator may fail to operate.

Old-type cone or horn speakers are scarcely suitable for use with this oscillator. Even assuming that an ordinary input transformer is employed, the output would be impaired by the poor sensitivity of this type of speaker.

If necessary, several pairs of earphones may be operated from the oscillator instead of the loud-speaker. The best method of connecting them depends on the number and the impedance of the phones and on the transformer secondary winding.

It may be found satisfactory to connect the phones in parallel across the voice-coil winding. In other cases, better results may be had by connecting them in series or series-parallel between plate and earth, with a suitable blocking condenser in circuit.

MAY ALTER THE NOTE

It may be found that the note will vary somewhat with different arrangement of the phones in the output circuit. It is therefore, a good idea to discover the most suitable combination and leave it at that.

As mentioned elsewhere, the note may be varied a certain amount by making the resistor R4 variable. However, the degree of control may not be sufficient to offset large variations in the output circuit.

An open circuit jack is placed in the cathode circuit of the valve so that the oscillator may be keyed. The oscillator may be left switched on and will not operate until the key plug is inserted into the jack and the key is depressed. When the jack is open, the full supply voltage is across the terminals of the key, but in series with the plate impedance of the valve. The latter would limit the current to such a small figure, that there is little chance of the operator receiving a shock.

(Continued on Page 66)

THE SERVICE-MAN WHO TELLS

By a Service Engineer of Radio Equipment Pty. Ltd.

Being some real-life stories of troubles which were experienced in a day's work. Maybe some day you will be worried by one of these problems. Read how this man solved them.

NUMBER ONE

The service ambulance brought in another patient a few days back. It was an AC receiver, which, when switched on, was found to be quite "dead." However, it's our job to bring dead 'un's back to life again, so we set to work.

Removing the output valve from its socket, which should have interrupted its plate current and produced quite a loud click from the speaker, made no sound whatsoever. In removing the valve I also noticed that it was very cool, indicating that no plate current was flowing through it.

On checking up the voltages which existed in various parts of the circuit, I found that the output from the rectifier tube, instead of being approximately 400 volts, was only about 220, and that on the output side of the field coil the voltage, instead of being 250, was zero.

LOW VOLTAGE

The fact that the rectifier was giving a low voltage, and that there was nothing at all coming from the output end of the field coil, indicated a short circuit from B plus to earth. The fault could not have been simply an open circuit in the field coil, because the rectifier in this case would give a higher voltage than normal, instead of a lower voltage.

On using an ohmmeter to check the resistance between B plus and earth, I found that there was no resistance at all, indicating a direct short circuit.

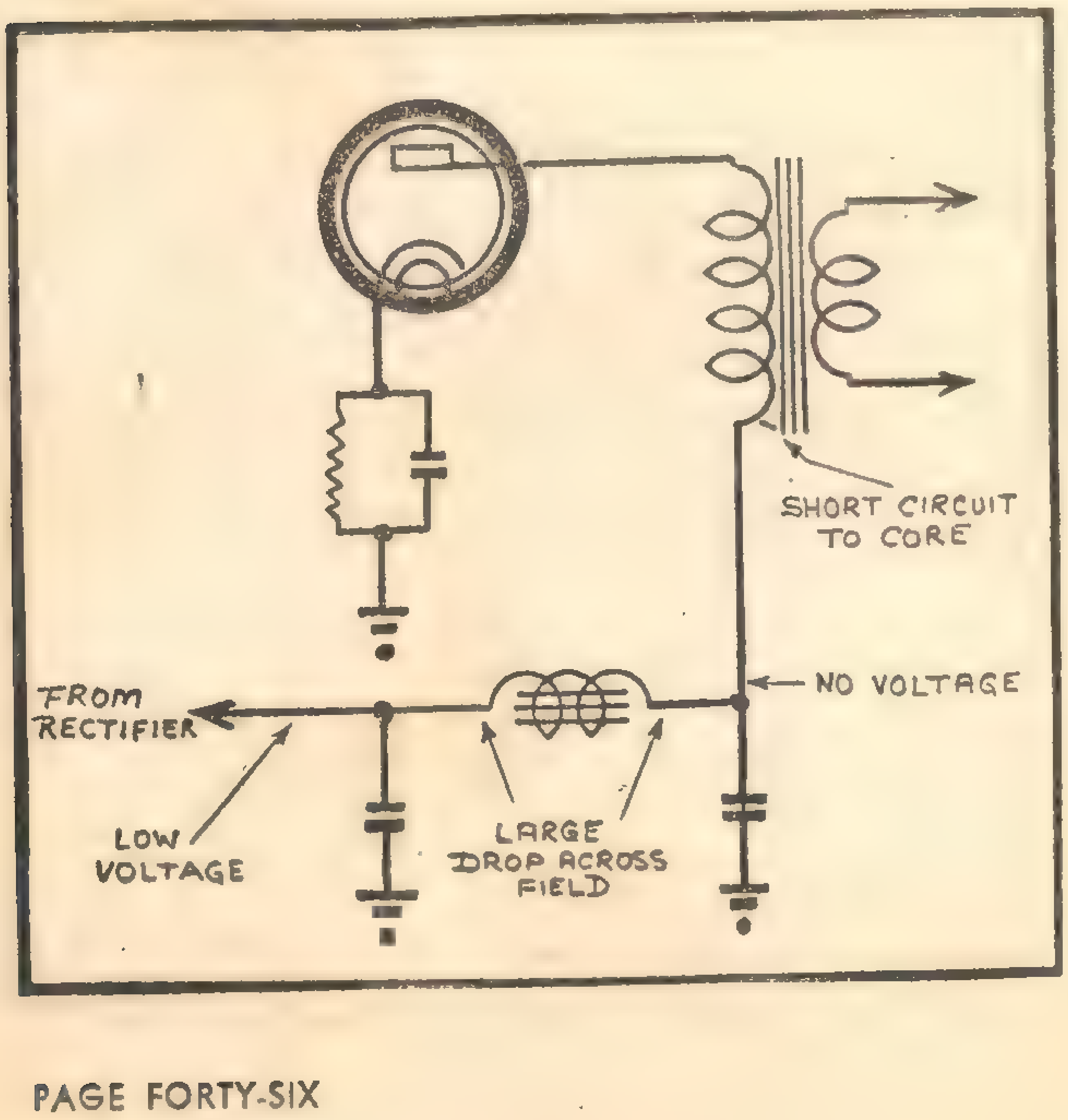
The next step was to check the different parts connected from B plus, one at a time, to find out in just which part the fault existed. After disconnecting one or two condensers and other parts, I decided to check the speaker itself. In this particular set, the speaker framework was bolted directly to the chassis, the two fitting into a midget cabinet.

FAULTY TRANSFORMER

In this case the framework was earthed and the insulation between the primary winding of the input transformer on the speaker, and the core of the input transformer, had broken down badly, causing a direct short circuit between the primary winding and the core. In this way current from the power supply unit, after passing through the field coil, was flowing to the damaged spot on the transformer primary winding, and from this spot through the faulty insulation to the core, thence to the chassis, and thus forming a short circuit.

It was not considered satisfactory to patch up the breakdown, owing to the little space available. One way of overcoming the trouble would have been to replace the whole speaker transformer. A cheaper way, however, was simply to obtain a new set of windings and to assemble these on the iron core of the transformer.

Whenever ordering replacement windings for speaker transformers, it is essential to specify the type number of the tube, which is connected to the primary, and also to specify either the voice coil impedance of the speaker or the make and model of the speaker, so that a transformer having both the correct primary winding and secondary winding can be supplied.



A short circuit between B plus and earth was traced to a breakdown of the insulation between the primary winding and the core of the output transformer, the speaker being bolted directly on to the chassis. It appeared impractical to repair the breakdown and a new set of windings was accordingly installed on the original core.

NUMBER TWO

Number Two had the very common fault of a noisy volume control. The trouble evidences itself quite frequently in both battery and AC operated receivers, by a scratching or crackling noise whenever the volume control is turned. Some radio sets are fitted with a volume control, which consists of a wire-wound potentiometer, while in others the potentiometer has a resistance element composed of a deposit of carbon on a piece of insulating material.

As the trouble with these volume controls is usually purely a mechanical one, the most satisfactory method of overcoming it is to replace them with new ones, but, if a new unit of the correct value is unobtainable, a temporary repair can often be made.

In the case of wire-wound potentiometers, inserting a thin piece of very fine glass-paper or sandpaper between the rotating arm and the resistance element will often clean away a deposit of dirt or corrosion, and, after any dust or dirt is removed by a piece of cloth, the control may be quite silent.

CARBON POTENTIOMETERS

Carbon type potentiometers are a little more difficult to deal with, but, with these, it is frequently possible to make a temporary repair by removing the dustproof cover at the back, and rubbing a piece of ordinary lead-pencil on the carbon strip.

The graphite in an ordinary lead-pencil is an electrical conductor, but it has considerable resistance. If the carbon film is damaged on the potentiometer, it is sometimes possible to repair this my simply using an ordinary soft lead-pencil and rubbing it several times over the patch where the crackling noise is experienced so as to form another carbon film. This, of course, is only a temporary measure and, as soon as possible, the unit should be replaced with a new one.

USING AN OHMMETER

If an ohmmeter is used for checking the resistance of a potentiometer, any noisy spots will usually be indicated either by a sudden jump or by no reading at all on the ohmmeter scale, as the shaft of the potentiometer is turned. A good potentiometer should give a gradual increase or decrease of resistance as the shaft is rotated, without any suggestion of jumpiness.

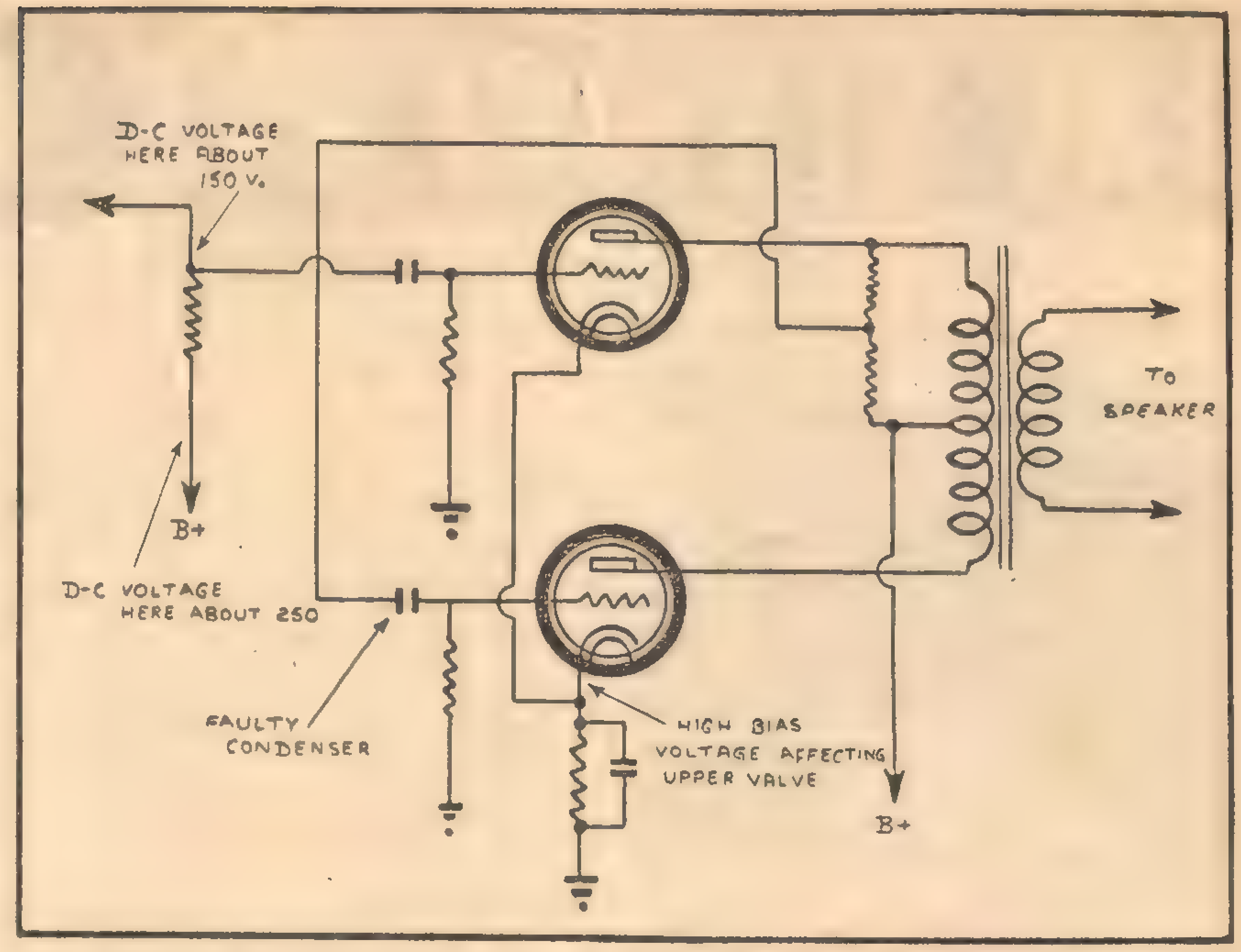
NUMBER THREE

Number three was a simple case of a broken down high tension bypass.

Quite frequently, in service work, one comes across a punctured tubular condenser of the paper dielectric type, particularly in the case of a plate bypass, a screen bypass or a coupling condenser. At first thought, these may seem to have an ample margin of safety in respect to their voltage ratings, with the results that the makers of the condenser come in for some abuse or criticism.

An examination of the circuit arrangement may soon show that the condenser has been subjected to a voltage far in excess of its voltage rating for a few seconds each time the receiver is switched on.

Most AC receivers employ a directly heated rectifier tube, which heats in about two seconds. The remaining tubes in the set are usually of the indirectly heated type, which may require 20 seconds or more to reach their normal operating temperature.



In this typical paraphase circuit, the breakdown of one of the coupling condensers caused a positive voltage to be applied to one grid. The cathode current was so high that the remaining valve was biassed to cut-off or thereabouts. To judge by the distorted nature of the output, only the peaks of signal were being amplified properly.

HIGH INITIAL VOLTAGE

This means that, for the intervening time after the rectifier is heated, it is delivering an extremely high output voltage, due to the fact that the remaining tubes are not drawing any current. The only load on the rectifier under these conditions is the small amount of current which may pass through the voltage divider, if indeed the receiver incorporates a voltage divider or divider network.

In the case of an ordinary type of AC operated receiver, employing a power transformer delivering 385 volts to each plate of the rectifier tube, fitted with a loudspeaker with a 2500 ohm field coil, and also a 15,000 ohm voltage divider, the current drain on the rectifier, during the time which the remaining tubes in the set are heating, is only about 25 MA. The result is that the voltage output of the rectifier rises to approximately 460 volts and the voltage at the B plus end of the voltage divider is approximately 400 volts.

GRID, SCREEN CIRCUITS

If we examine the circuit of an ordinary type of set, we will see that the coupling condenser is connected to the B plus end of the voltage divider through the resistor in the plate circuit of the detector tube. Similarly, there may be one or more of the screen grids of the tubes in the receiver, operated directly from B plus through a voltage dropping resistor.

Now, the condenser connected from the screen to earth, and the coupling condenser will be subjected to the full voltage at the B plus end of the voltage divider until the tubes warm up, because, with the tubes drawing no current, there will be no voltage drop through the resistors in series with the condensers, and therefore, the full voltage at the B plus end of the voltage divider will be applied to the condensers.

For this reason it is absolutely necessary to employ tubular type condensers, with a voltage rating of at least 400 in ordinary types of receivers. The normal voltage applied to a coupling condenser or screen bypass condenser may only be in the vicinity of 100 or 150 volts, but it must be borne in mind that this voltage is that which exists during the normal operation of the receiver, after all the tubes have heated. Due allowance must be made for the voltages which exist during the heating-up period of the tubes.

FURTHER EXAMPLES

In the case of a receiver with a lower resistance speaker field coil or a higher resistance voltage divider, the voltages existing during the heating up period are even higher than those just mentioned.

Again let us assume an ordinary type of power transformer delivering 385 volts on each side of the secondary winding, and an 80 or 5Y3G type rectifier. If the receiver is equipped with a loudspeaker employing a 1000 ohm field coil and a voltage divider having a resistance of 25,000 ohms, then the maximum output voltage from the rectifier will be in the vicinity of 480 volts, and the voltage at the B plus end of the voltage divider will rise to 460 volts during the heating up period. If a 5Z3 or 5U4G rectifier is used in place of the 80, then the voltages will be 500 and 480 volts respectively.

ELEMENT OF RISK

Although 400 volt rating condensers will probably last, under these conditions, for a considerable period of time, nevertheless, it should be realised that during the heating-up period, these condensers are subjected to a considerable overload.

To provide an adequate margin of safety in the case of a receiver operating with a high resistance voltage divider or a low resistance field coil, it would be advisable to employ condensers having a working voltage rating of at least 600, but as these are considerably more expensive than the normal 400-volt type, most manufacturers prefer to employ the 400-volt rating condensers, because, generally speaking, these can stand a certain amount of overload without reducing their life to any great extent.

COUPLING CONDENSERS

In the case of coupling condensers connecting the plate of the audio voltage amplifier to the grid of the output tube, it is more important to see that an adequate voltage rating is employed. A leaky condenser in this position usually means that the power output tube is subjected to a considerably heavier plate current than its normal value, with the result that the cathode of the tube is often damaged, and the tube ruined.

This is brought about by the punctured condenser allowing the positive voltage from the plate circuit of the preceding tube to pass through on to the grid of the power tube, resulting in a positive grid bias and heavy plate current.

INDIRECTLY HEATED RECTIFIERS

High voltages during the warming up period are not experienced in radio receivers fitted with indirectly heated rectifiers such as the 83V or 5V4G. In this case the rectifier takes just as long as the remaining tubes in the set to heat up, with the result that, by the time the rectifier is operating, the remaining tubes are ready to absorb their share of the current, and the voltage never rises much above the normal working value.

(Continued on Page 49)

Mr. L. B. GRAHAM
Principal of the A.R. COLLEGE.

Do you know?— About Electric Motors

By way of a change, Mr. Graham proposes to digress for the time from purely radio theory and to discuss, in the next few issues, the theory of electric motors. A general knowledge of electric motors is often valuable to the radio enthusiast. This, the first article, deals mainly with the electrical theory upon which a discussion of electric motors is necessarily based.

THE operation of any type of motor naturally depends on the action or effects of the electrical power supplied to the motor. For this reason it will be necessary to have some knowledge of the fundamentals of electricity and magnetism.

Scientists tell us that all matter, regardless of its nature or state, fundamentally consists of two types of electrical charges. One type of charge is called a positive charge, and the other type a negative charge.

Electricity itself, before any work is done upon it, contains no energy, and consequently cannot be made to do any work, but electricity which has been put into motion so that it circulates around some conducting path does contain energy, and can be made to do work. Therefore, we require a movement of electricity or a flow of electric current in order to make our motors operate.

Electricity can often be likened to water; water at rest contains no energy and can do no work, but once a current or flow of water is set up the water can be made to operate various types of hydraulic machines, so that work is done.

To set water in motion, or to make it flow through pipes or through a machine we require some pressure behind it. This pressure is generally measured in lbs./sq. inch. Similarly, to make an electrical current flow in a circuit we also require pressure. Electrical pressure is not measured in lbs./sq. inch, but in a special term known as voltage. The voltage, then, of an electrical circuit, specifies the amount of pressure trying to force current to flow.

AMPERES

In a water system we measure a current of water, or the rate of flow of water in gallons per second, gallons per minute, or some other such term. In an electrical circuit we also have a system of measuring the flow of current, or rate of flow of electricity. The unit used in electrical circuits is the ampere.

It is not necessary to say "amperes per second" or "amperes per minute," because the term "amperes" takes into consideration the amount of electricity passing a certain point in a circuit in a second. Thus we can see that where we would speak of the rate of flow of water in gallons per second, we would speak of the rate of flow of electricity in amperes.

The difference between the terms voltage and current should be clearly understood. The term voltage refers only to the pressure which tries to force current to flow around the circuit and to nothing else; while current means the rate of flow of electricity as measured in amperes.

ELECTRICAL POWER

The amount of work which can be done by a circuit, or the power of a circuit, depends not on the voltage or current alone, but on the combined effect on the two. To do a certain amount of work we can employ a low voltage and large current, or a large number of amperes, a medium voltage and a medium number of amperes, or a high voltage and small number of amperes.

This means that the power or work which can be done by an electrical circuit is proportional to the voltage applied to the circuit multiplied by the rate of flow, or amperes, of current circulating.

The unit used to measure the power of a circuit is called the watt. One watt of power is produced by one volt of pressure forcing a current of one ampere to flow. In other words, the power in watts equals the pressure in volts multiplied by the current in amperes.

HORSEPOWER

There is also a relationship between the power in watts in a circuit and the horse-power developed by the circuit. It takes 746 watts of power to equal one horse-power.

In many instances you will find abbreviations used for the terms voltage, amperes, and watts. Voltage is commonly abbreviated to volts, or simply

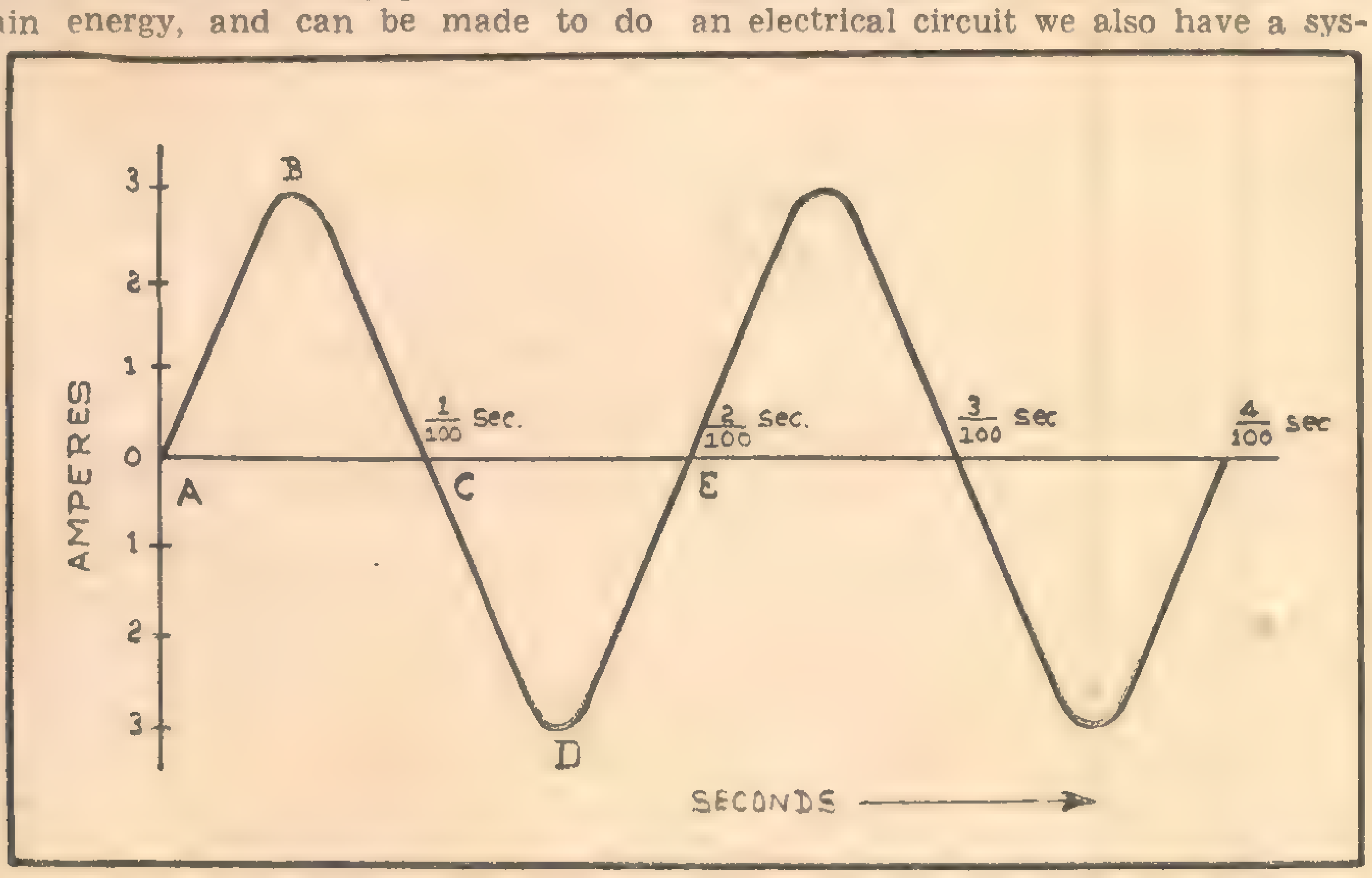


Figure 1. In the case of A-C power supplies, the direction and strength of the current flow is not constant and varies in a periodic manner. With the usual 50 cycle supply the current rises to a maximum in one direction, returns to zero, rises to a maximum in the other direction and returns again to zero, fifty times each second. Two complete cycles are shown above.

IT'S WORTH MILLIONS — IF IT WORKS!

(Continued from Page 7)

internal-combustion engine, the motion picture, radio, the aeroplane, the linotype, the induction motor for alternating current, electric welding, and the audion or electron tube which gave wireless a voice.

It is upon inventions of this kind that great industries are based. They have earned millions on millions, not only for their inventors, but for the investors who bought or leased the patent rights, and for the thousands of inventors who have patented improvements on the basic inventions, to say nothing of the millions of uninventive folk for whom they have created comforts and jobs at better wages.

Maybe your invention will rock the world and change the face of civilisation, too. You never can tell. George Westinghouse didn't think his air-brake amounted to much, but it made a large fortune for him and revolutionised railways.

VARIOUS MOTIVES

The ideas for inventions don't always spring from the altruistic motive of benefiting the human race, or even from a desire to make money. The dial telephone exchange owes its existence to a suspicious American undertaker who thought a business rival had bribed the telephone operators to bungle his calls. This set him to working out what he called the "girlless exchange."

Sheer timidity led Dr. Rene Laennec, a French physician, to invent the stethoscope. The doctor was bashful about putting his head to the bosoms of his lady patients. One day, while on his way to visit a lady whose bosom filled him with trepidation, he noticed a couple of children sending signals through a board. One would scratch his end of the board, the other would listen at the other end.

The thought flashed upon the doctor that he might use the same principle to listen to the chest of his patient. So he shaped a piece of hardwood for his special needs, applied the far end to his patient's chest, the near end to his ear. From this crude beginning has developed the amazingly sensitive instrument now used by physicians.

LAZY INVENTOR

The desire of Humphrey Potter to play won for him undying fame as an inventor. In the early Watt steam engine, the steam was alternately admitted to the opposite ends of the cylinder through cocks turned by hand. It was Potter's job to turn the cocks. By tying strings to the cocks so that the engine would itself turn them, he freed himself so that he could play.

There were accidents all along the line in the discovery of ethyl as an anti-knock ingredient in petrol. After a great deal of research, Charles F. Kettering, chief of research for General Motors, and Thomas Midgeley, jun., came to the conclusion that the knock must be due to the color of the gasoline.

An assistant was sent to the chemical storerooms for a coloring matter which would completely dissolve in petrol. The storekeeper did not know off-hand any such chemical, but his eye fell upon a bottle of iodine, and he handed it out in the hope that iodine would dissolve in petrol and certainly would give it color. The knocking disappeared instantly.

COINCIDENCE

Now, out of over ten thousand bottles of chemicals in the storeroom, it happened that just one bottle contained material that would eliminate knock! While their earlier theory was found to be wrong, iodine furnished Messrs. Kettering and Midgeley with the knowledge that materials of the bromide family would prevent knocking. This clue ultimately led to the invention of tetra-ethyl lead.

Kettering figured indirectly in the discovery of one of the more important of the recent improvements in motor engines, the so-called "tin-plated piston." Engineers in the General Motors laboratory were supervising an endurance test run on a transmission unit. Just as word came that Kettering was coming to inspect the test, the pistons of the motor began to slap under wear and heavy load.

One of the engineers proposed, as a temporary measure and in order that the "Boss" might see the test in operation, that they build up the worn pistons by coating them with tin. The coated pistons were replaced. The engine ran along for months, so long, in fact, that the curiosity of the engineers finally became aroused, and it was only then that the surprising wearing qualities of the tin coating became appreciated.

SO IT GOES ON

The untiring effort of hundreds of inventors have finally given the lie to the old adage that "Necessity is the mother of invention." In the modern world, necessity is more nearly the child of invention, than its mother. Most of the inventions that once were regarded as luxuries are now regarded as constituting the bare necessities of life.

NOVEL TEN WATT AMPLIFIER FOR P.A.

(Continued from Page 43)

In our amplifier you will see that we stood some of these components on end and connected the earthed end directly to one of the earth terminals. The components associated with the output valve are not so important and can be earthed at the most convenient point.

When wiring the electrolytic condensers watch the polarity of the connections. The polarity of each of the electrolytic condensers is clearly marked on the circuit diagram and you will have no difficulty in getting things right. The main point is not to forget.

For the rest, there is little to worry about and it is merely necessary to follow the usual rules of assembly and wiring.

A FEW HINTS

If you are not used to building radio gear, do not be in too great a hurry. Make sure that every soldered joint is secure before you pass on to the next. Resin colored solder is probably the best solder to use. If the solder does not flow evenly over the joint, use a smearing of good flux.

Never use more flux than is absolutely necessary. If you do, you will find that it will run under the lugs, when heated, and form a sticky mess, which looks bad, and is bad.

Do not make the connecting leads longer than necessary, but run them where they will "stay put."

Mount the condensers and resistors as firmly as possible and in such positions that they will not come adrift when the chassis is subjected to vibration and bumping. If you cannot manage it otherwise, a loop of stout thread around the condenser and under some fixture will often keep it in place.

If the leads to any of the condensers or resistors have to be extended, use a small piece of fine busbar and slip a piece of spaghetti tubing over the extended lead. This method is preferable to tacking a small piece of hook-up wire to the end of the lead. The result is seldom rigid and increases the possibility of short-circuiting the other leads.

If in doubt as to where a lead goes, do not guess at it, but study the underneath wiring diagram and the circuit carefully and endeavor to make quite sure.

There is little more than can be said and it remains to do the actual building.

When the amplifier is first switched on, watch the rectifier carefully in case there happens to be short-circuit anywhere. If the rectifier shows any signs of a blue glow between filament and plate, switch off immediately and search for a short between B plus and earth.

If you cannot locate anything wrong, it may be that one of the electrolytic condensers is faulty. If no means are available for testing the condensers, try the effect of disconnecting them one by one and see if the amplifier then heats up normally.

OSCILLATION

If the amplifier should break into uncontrollable oscillation, when switched on, the chances are that you have the output valve circuit mixed up somewhere. Switch the amplifier off again and see that you have the feedback connected to the correct output valve.

Another possible cause of oscillation is the failure to earth the input circuit or the associated shielding. However, these points are just mentioned in case you strike trouble.

In actual practice you should have no such difficulties and the amplifier should operate satisfactorily "from the word go."

THE MONTH ON SHORT WAVES by Ray Simpson

Australian Reply To Jap Propaganda

ENEMY CLAIMS REFUTED

For many weeks now the Japanese have been broadcasting news commentaries into which have been woven much subtle propaganda. Unfortunately many of the threats and predictions have been only too true and this may have influenced some listeners in believing that everything heard from Tokio was bound to be true.

IF this is the case they have unconsciously become defeatists which is exactly what the Japanese intend them to, and is possibly the main intention of these broadcasts.

It is, therefore, reassuring to learn that the Australian authorities are now preparing to counter this enemy propaganda and at the same time give the Japanese people a few home truths to consider as well. Let us hope that these Australian broadcasts will be carefully planned and delivered in a more convincing manner than some of our previous efforts.

SEASONAL CHANGES

The seasonal change is already becoming noticeable, as some of the daylight stations can now be heard again, and before long we will be able to have lunch-time reception. The effect of this change will also be felt at night, as the higher-frequency stations, especially those in the 16 and 19 metre bands, will gradually fall off until reception will only be very spasmodic. Stations on the 13-metre band have already practically disappeared in most locations, though now and again on a favorable night, some of the Empire transmitters can still be heard.

DAYLIGHT SAVING TIME

At the time of writing these notes it is not clear as to whether daylight saving time will stop at the end of March or continue for a further period. Will readers therefore please remember that all times shown in this issue are Daylight Saving Time in Eastern Australia and take this into account in the event of Standard Time being reverted to on April 1?

TWELVE MONTHS IN RETROSPECT

R. & H. SCOOPS DURING THE PAST YEAR

IT seems only a short time ago since our first number yet this issue begins our fourth year of publication. At the end of each volume we usually review our efforts during the preceding twelve months, so we accordingly list below what we consider our best scoops in Volume 3.

In the last twelve issues we listed 121 new stations and of this total "Radio and Hobbies" was the first Australian magazine to list approximately 80 of them, which is about 66 per cent. This we think is good for a monthly publication, as the weeklies have many more opportunities of printing details of new stations heard.

Some of the best stations which we were first to report were Radio Addis Ababa, Radio Ponta Delgado, Radio Denmark, ZOY, HHBM, CBFY, SUP2, CFCX, ZHN3, ZHN9, ZRD, PLS, HI1J, HI3C, and PRE9.

Perhaps our most popular feature in the short-wave notes has been "Who's Who in S.W. Broadcasting," as we are continually receiving letters of appreciation concerning this section. Another popular column is "This Month's Verifications," as it gives readers an idea as to what shape their verifications will take and also from what stations cards can be expected. While the war is on, of course, this must be accepted with reservations.

When Volume 4 comes to an end we hope that the short-wave section will still have as large a following as we have at the present time, and if the same help is given by our readers as in the past, we feel sure that this will be the case.

A large measure of this year's success has been due to those enthusiastic listeners who have advised us by letter and even telegram of anything new which they have heard, consequently helping to maintain our reputation of being first with the news of new stations.

COSTA RICA

TWO STATIONS ON 25.21m

READERS will remember that in the February issue we reported hearing TIEMC on 11,900kc, 25.21m, and we mentioned that we had heard two different addresses given for this station, namely, PO Box 849 and also Box 1167. Also, different slogans were heard when the station was on at night to what was given when it was logged late on a Sunday afternoon. It would now appear that there is two different stations using this same frequency as, according to the latest Globe Circler, the one with the address Box 849 is TIJMT, "Radio America Latina," so the other will be TIEMC, as we have quite definitely heard this call given on more than one occasion.

CHUNKING SCHEDULE

THE Chiness International Broadcasting Station has just sent us their latest schedule which we publish in part below.

To North-West Europe, 5950kc., 8.30 am till 9.15 am.
To North America, 11.900kc. 5.30 pm.
To Hawaii, 11900kc., 7 till 7.30 pm.
To Australia and New Zealand, 11,900 kc., 9.15 pm.
To SE Asia, 11,900kc., 10.30 pm.
To South Seas, 11,900kc., 11.30 pm.
To North America, 5059kc., 1 till 2 am.
To Near East, 11.900kc., 2.35 till 2.45 am.

Variations in the above have already been noted, but this should serve as a guide.

STOP PRESS

NEW MEXICAN STATION ON 31.39M.

A NEW Mexican station can now be heard daily till closing at 5.5 pm. Gives English on closing, and think call letters are XETA.

VLQ8 16.85M. AGAIN IN USE

The Sydney station VLQ8, 17,800kc., is again in use daily from 5.55 pm till 6.15 pm, in session for the British Isles.

OAX5C IS NOW ON 9540KC., 31.45M.

The well-known Peru station can now be heard on Sundays at good strength till closing at 5 pm with "Lover, Come Back to Me."

PERTH NOW USING 9615KC., 31.21M.

The Perth national SW station has recently moved to a new frequency, 9615kc., and opens there at good strength at 10 pm.

2RO12 ROME VERY LOUD AT 5 PM.

The Rome station 2RO12, 15,100kc., 19.86m., has been heard lately at excellent strength, reading messages to Italian people in Ethiopia, Eritrea, and Somaliland.

WHEN AND WHERE TO LISTEN

Here is a chart for quick reference, giving the call and listening times for the best short-wave stations on the air. Where the station is not receivable at good strength when it comes on the air, the time is given at which reception should be satisfactory.

6 AM TILL NOON

Radio Cairo, 50.17m. Fairly good till closing at 7.30 am.

ZRH, 49.95m, Johannesburg. Quite good at 7 am.

DXX, 48.86m, Berlin. Loud station at 6 am.

GRN, 48.43m, Daventry. Loud station at 6 am.

GRJ, 40.98m, Daventry. Loud station at 6 am.

WRUW, 30.93m, Boston. Good strength at 9 am.

GRH, 30.53m, Daventry. Quite good at 8.15 am.

CSW6, 27.17m, Lisbon. Excellent at 6 am.

WLWO, 25.62m, Cincinnati. Good at 9.30 am.

Best reception period from 6 am till 10 am.

NOON TILL 6 PM

GSB, 31.55m, Daventry. Good strength at 6 pm.

2RO3, 31.14m, Rome. Very good in late afternoon.

HVJ, 25.55m, Vatican City. Excellent opening at 6 pm.

COCY, 25.55m, Havana. Quite good some days at 4.30 pm.

GSD, 25.53m, Daventry. Fair in afternoon, also at 5.30 pm.

XEWW, 31.57m, Mexico City. Quite nice signal around 4 pm.

WNBI, 25.23m, New York. Fair strength at 4 pm.

VUD, 19.62m, Delhi. Fair strength at 5.30 pm.

Best reception period from 3.30 pm till 6 pm.

Please send reports for next issue to reach us not later than Monday, April 6, 1942

6 PM TILL MIDNIGHT

GSV, 16.84m, Daventry. Very good at 10 pm.

2RO20, 16.87m, Rome. Good strength at 11 pm.

DJR, 19.56m, Berlin. Excellent at 10.30 pm.

CBFY, 25.63m, Montreal. Good from 11.30 pm.

JZJ, 25.42m, Tokio. Loud station at 8 pm.

Radio Saigon, 29.29m. Loud station at 10 pm.

XGOI, 31.04m, Shanghai. Quite good at 11 pm.

VUD4, 31.28m, Delhi. Good strength at 11.30 pm.

KGEI, 41.38m, San Francisco. Excellent at 11 pm.

Best reception period from 7 pm till midnight.

NEW STATIONS OF THE MONTH

U.S.A. — ENGLAND — ITALY

QUITE a nice little bunch of new stations this month, including three more Daventry transmitters and also some interesting stations in the United States. We also give more information concerning Freedom Radio located somewhere in the Philippine Islands.

KJE8—KJE9 LOS ANGELES

What are possibly the loudest USA stations we have ever heard were logged for the first time early one Sunday morning from just after midnight till well after 2 am. The first one was KJE8, on a frequency of 9390kc. 31.95m., which evidently opened at midnight and continued on this frequency till 1 am, when it closed down.

The programme consisted of excellent recording of Strauss waltzes, and in between each record the following announcement was made:—"This is Station KJE8, Press Wireless Inc., Los Angeles, Cal., USA, testing programme channel service on a carrier frequency of 9390kc."

As stated above, this station closed at 1 am, but it was replaced one hour later, at 2 am, by another one, KJE9, on a frequency of 10,750kc. 27.91m. Same type of programme. Strength was exceptionally good, being louder than KGEI even in the old days, when this station was heard so well out here. We should imagine that Press Wireless, Inc. would verify reports on the above two transmissions.

Another new Hawaii station is KEQ, on 7370kc. 40.71m., concerning which we have just received a telegram from our good friend Dr. Gaden. The station was heard at 11 pm, and was possibly relaying the usual General Electric programme from the Fairmount Hotel.

GRD—GRK—GRM, DAVENTRY

The Empire station is again extending, and another three new outlets have been heard during the past week, details being as follow:—GRD, 15,450kc. 19.42m., is quite good at night till closing at 8.30 pm, and also in the early morning till 2 am. GRK, 7185kc. 41.75m., not used regularly, but often heard around 7 pm and more regularly at 3 am; and, finally, GRM, on 7250kc. 41.38m., which gives foreign programmes around 3 am.

FREEDOM RADIO

As briefly reported in our stop-press panel last month, there is now a Freedom Radio operating somewhere in the Philippine Islands. The channel used is 9645kc. 31.1m., just slightly higher in frequency than the old KZRH, which is also on the air.

When first heard, it used to close at about 9.50 pm, but now stays on the air much later. The news in English is given at 9.30 pm, and can be followed quite well on most nights. This station can also be heard in the mornings, when it opens at 9.30 am, but is not as good at that time as it is at night. Long may they continue on the air in the cause of freedom.

NEW GERMAN DXR

Another new German station has recently opened up on the 25-metre band, this one being DXR, on 11,760kc. 25.51m., and is heard well in the mornings at 7 o'clock and can also be logged in the afternoon at 5 o'clock, but is much weaker at that time.

The Italians have also opened up another new outlet in the same band, this one being on 11,945kc. 25.12m. and is heard at quite good strength in the mornings, when it is used in parallel with 2RO4. No call letters have been heard for this new station, as they do not appear to be giving separate calls now for each frequency used.

NEW YORK STATIONS

Since writing the body of these notes, we have heard WCRC opening at midnight on 17,830kc. 16.83m., though strength is not as good as WCBX, with the same programme, on 15,270kc.

The other New York station, WNBI, has been logged on an entirely new frequency—namely, 17,880kc. 16.78m.—this one with the same programme as WNBI, on 17,780kc. The new channel appears to open at 1 am, while the regular one, 17,780kc., starts at midnight.

READERS' REPORTS

WE are very grateful to the following readers who have sent in interesting letters and reports on their station loggings:—Mr. J. Buckley, Goulburn, NSW; Mr. L. Walker, Applecross, WA; Mr. R. K. Clack, Beresfield, NSW; Dr. K. B. Gaden, Quilpie, Qld.; Mr. L. R. Suleau, Roseville, NSW; Mr. A. Lee, Newcastle, NSW; Mr. H. Perkins, Malanda, Qld.; Mr. G. Obey, Bronte, NSW; Mr. A. S. Condon, Laura, SA; Mr. B. W. Battis, Speers Point, NSW; Mr G. Jones, Seymour, Vic.; Mr. M. Foster, Mount Vincent, NSW; Mr. G. Smart, South Caulfield, Vic.

WITH OUR S.W. REPORTERS

MR. L. WALKER

THIS month we are able to give some information concerning one of our Western Australian listeners, Mr. L. Walker, of Applecross. This listener is a comparative newcomer to short-wave listening, having first become interested in the hobby in 1939, but since that time has rapidly increased his log of stations and now has a very commendable total.

COMMERCIAL RECEIVER

Mr. Walker is at present using a well-known commercial receiver of six valves, including a stage of RF amplification. This receiver tunes from 15 to 52 metres, and thus covers all main bands.

The aerial at present in use is only of a temporary nature, and in the near future he intends erecting a 60ft. inverted L type about 30ft. high. Many other types have been tried, but, taken all round, this listener considers the inverted L to give the best signal-to-noise ratio.

FAVORABLE LOCATION

Unlike some of our other listeners, Mr. Walker considers he is favored by a good location, being in a high position overlooking the Swan River, well back from the road and consequently not troubled by interference from automobiles, &c. Neither trams nor trolly buses come within a mile of his house, so he is indeed to be envied at being so free from man-made static.

This listener's favorite stations are those located in North and South America, especially the latter, though stations in that continent are harder to receive. The Africans are also popular, but this requires very early rising, which is harder than logging the stations.

One card from each country is this reader's first objective in the way of verifications, and at the present time he has about 30 cards from 19 countries. Among the best cards received so far are COK, HCJB, YUB and WRCA, while reports are out to COBC, XEWW, CR7BE, ZRH, and one or two others. Let us hope that they will all turn up before very long.

S-W CLUB MEMBERS

Mr. Walker is a member of the Short-Wave Listeners' League of WA and also the All-Wave All-World DX Club, and contributes to several Australian radio magazines. "Radio and Hobbies" has been taken since the first number, and some of the issues have been bound in order to preserve them. The features "Who's Who in SW Broadcasting," "Flashes from Everywhere," and "The Month on Short Waves" are especially interesting to this Western Australian listener, though he is also a keen reader of all the constructional articles.

UNITED STATES S.W. STATIONS

WE show below the latest list of frequencies allotted to the various short-wave stations located in the United States of America.

WCBX, New York, NY, 6120, 6170, 9650, 11,830, 15,270, 17,830, 21,570 kc. Conditional, 6060 and 21,520 kc.

WCRC, New York, NY, 6060, 6120, 6170, 9650, 11,830, 15,270, 17,830, 21,520, and 21,570 kc.

WRCA, New York, NY, 9670 and 17,780 kc.

WNBI, New York, NY, 6100, 11,890, 15,150, and 21,630 kc.

WGEA, Schenectady, NY, 6190, 9550, 15,330, 21,500, and 21,590 kc.

WGEO, Schenectady, NY, 6190, 9530, and 15,330 kc.

WLWO, Cincinnati, Ohio, 6080, 9590, 11,710, 15,250, 17,800, and 21,650 kc.

WCAB, Philadelphia, Pa., 6060, 9650, 11,830, 15,270, 21,520, and 25,725 kc.

WRUL, Boston, Mass., 6040, 11,730, 11,790, 15,130, 15,350, 17,750, and 21,460 kc.

WRUW, Boston, Mass., 9700, 11,730, 15,130, 11,790, 15,350, 17,750, and 25,600 kc.

WRUS, Boston, Mass., 6040, 11,730, 11,790, 15,130, 15,350, and 17,750 kc.

WBOS, Boston, Mass., 6140, 9570, 11,870, 15,210, 17,780, and 21,540 kc.

KWID, San Francisco, Cal., 6060, 9570, 11,870, 15,350, 17,760, and 21,610 kc.

KGEI, San Francisco, Cal., 6190, 9530, 9670, and 15,330 kc.

THIS MONTH'S VERIFICATIONS

CB1174.—Santiago, Chile. 11,740k.c., 25.55m. We first reported to this station on April 10, 1939, and have followed up with three letters since that date, so were quite pleased to get their letter of verification a couple of weeks ago. Station is known as Radio Hucke, and re-broadcasts CB93. Address is Orlandini and Raggio, Ltd., Cassilla 6009, Santiago, Chile.

CR7AA.—Lourenco Marques, Mozambique. 6170kc., 48.62m. The Radio Club of Mozambique has sent us its attractive red and white card verifying our report of this station heard on above frequency on August 9, 1941. Another card was also sent for CR7AA for its other frequency of 6030kc., 49.75m., this being verification of our report dated September 20, 1940. By the same mail they also sent us card for CR7BE, verifying our report of this station on its present frequency of 9830kc. Accompanying the cards was a very courteous letter in English by the manager of the club. Its address is: PO Box 594, Lourenco Marques, Mozambique.

FLASHES FROM EVERYWHERE

MANCHUKUO.—The Hsinking station, MTCY, has been heard carrying out tests with Rome on 9535 and 11,775 kc., and also a new frequency of 15,545kc. These tests came over at 6.40 pm and were heard by Mr. Whiting, of Five Dock, who kindly advised us in his report. There is no doubt these Axis fellows are in close contact all right.

CHINA.—During the past few weeks we have had our letters returned by the postal authorities as being undeliverable in Shanghai and Chungking. The letters concerned were to XGRS and XGOY, so it would appear to be useless sending any more reports to either of these stations, or for that matter to any others located in China.

BRAZIL.—Two additional stations have recently come on the air in this country, details of which are as follow: PRF3 on 6095 and 11,765 kc., located in Sao Paulo, power 25kw., and operates from 8 am till 12.45 pm from E.A.S.T. Address is PO Box 252. The other one is PRE9 in Fortaleza, using 6105 kc. from 7 am till noon E.A.S.T., and 15,165kc. from 11.40 pm till 2 am. We have already heard the first frequency. (Globe Circler.)

BRITISH GUIANA.—"The Voice of Guiana," owned by the British Guiana United Broadcasting Co., will soon have a new 1kw. transmitter in use for their sw station, ZFY, in Georgetown. They are anxious for reports to be sent to PO Box 272. They are now operating on 6080 instead of 6130 kc. (Globe Circler.)

FINLAND.—The call letters of the Finnish short-wave stations have been changed and are now as follow:—OIX1 6120kc., OIX2 9500kc., OIX3 11,780kc., OIX4 15,190kc., OIX5 17,800kc., OIX6 21,550kc. It is impossible, of course, to send reports to these stations while the war is on.

PARAGUAY.—This country is not often referred to in short-wave notes, one of the only stations heard being ZP14 in Villarica. According to the Globe Circler, there is now another one on the same frequency, 11,721kc., namely, ZPA2, "Radiodifusora de la Telico Paraguaya," located in Asuncion, which relays ZP10, "Radio Guarani," from 9 am till 11.40 am and also from 11 pm.

PALESTINE.—A new country will shortly be available for listeners, as the Army Department intend establishing a station at Jerusalem for the benefit of the AIF in the Middle East. Army engineers will instal the transmitter under the direction of a Sydney Post Office Engineer. Details of frequencies and call letters are not yet available. The cost of the station will be about £5000.

USA.—The new station in San Francisco mentioned in last month's issue will use the call letters KWID, so keep a look-out for it. Another American to watch for is KNBC, which is testing from 2 am till 9 am on 12,862kc., and from 9.10 am till noon on 9135kc. Either of these frequencies could be heard here.

OVERSEAS S.W. STATIONS NOW AUDIBLE

The list of stations shown below comprises only those which have actually been heard in this country during the past few weeks, and does not include stations which are on the air but not heard as yet in this country. A large majority should be heard on any sensitive receiver, and when a station is reported for the first time, readers' names who report it are shown in brackets. At the end of each group is a list of our correspondents who have sent in reports on these stations.

ENGLAND

L TIMES SHOWN ARE EASTERN DAYLIGHT SAVING TIME

SA.—6050kc., 49.59m., Daventry. Used for the European service in the early morning, but often has a swirling noise on the carrier.

SB.—9510kc., 31.55m. One of the best stations used in the Pacific service in late afternoon and s also very good at 1 am.

SC.—9580kc., 31.32m. Not a particularly good station now in the North American session in forenoon.

SD.—11,750kc., 25.53m. Heard in the mornings at 6.45 am, in afternoons at 3 pm, and in the Pacific session is usually very good.

SE.—11,860kc., 25.29m. Never very loud, but can usually be heard in the late afternoon around 5 pm.

SF.—15,140kc., 19.82m. Good strength in the Pacific service and also in the Eastern service around 10.30 pm.

SG.—17,790kc., 16.86m. An excellent station at 0 pm in foreign language programme and can also be heard at 7 pm.

SI.—15,260kc., 19.66m. Not one of the best but s usually audible at night around 7 pm or later.

SL.—6110kc., 49.1m. Heard in very early morning and also reported by readers as heard at 5.30 pm.

SN.—11,820kc., 25.38m. Can be logged in the mornings at 6.30 am and also at night from about 0 pm.

SO.—15,180kc., 19.76m. Can still be heard faintly when it comes on the air at 11.15 pm.

SP.—15,310kc., 19.6m. Occasionally heard around 7.30 pm, but is much louder opening at 9.30 pm.

SV.—17,810kc., 16.84m. Holding up remarkably well at night in the Eastern service and is again excellent at 2 am.

SW.—7230kc., 41.49m. Reported by some readers as heard around 7.30 pm, but not heard at our location during the past month.

RD.—15,450kc., 19.42m. Another new outlet which has been heard closing at 8.30 pm and also closing at 2 am. See article.

RE.—15,375kc., 19.51m. Has been heard at good level around 9.45 pm. Notice the revised frequency and the above one is correct.

RG.—11,680kc., 25.68m. Nice, steady signal around 6.30 am, but is not particularly strong.

RH.—9825kc., 30.53m. One of the best Daventry stations in the morning when it opens at 8.15 am and can be followed till well after 9 am.

GRI.—9415kc., 31.86m. Does not appear to be regular but has been heard some nights around 10.30 pm.

GRJ.—7320kc., 40.98m. This is a loud station, both in mornings at 7 am and also at night at 7 pm.

GRK.—7185kc., 41.75m. We have heard this new one for some time now at 7 pm and also 3 am, but have only just found out call letters.

GRM.—7250kc., 41.38m. Still another new one used in foreign language programme at 3 am.

GRN.—6195kc., 48.43m. Excellent strength from this outlet in the very early hours and is also good around 6 am.

GRO.—6180kc., 48.54m. Have only heard this station in the early morning hours in the African session.

GRP.—17,890kc., 16.77m. Not very good now but can always be heard at night from about 10 pm or later.

GRQ.—18,030kc., 16.64m. At some locations this one is good but it is very weak with us just now.

GRR.—6075kc., 49.38m. Can be logged at good strength in the mornings around 1 am.

GRS.—7065kc., 42.49m. This is another good outlet for the Pacific session, especially round 6.45 pm.

GRU.—9450kc., 31.75m. Has not been heard at our location but is still reported by some readers as being logged at 12.30 am.

GRV.—12,040kc., 24.92m. Very good strength from this station just after midnight and also heard at 7.30 am.

GRW.—6145kc., 48.82m. This outlet is used for the Home Service programme and is quite good after midnight.

GRX.—9690kc., 30.96m. Not very good now in most locations but is still audible in the European service at 7 pm.

GRY.—9600kc., 31.25m. This outlet has been heard at the unusual time of 10 pm, but is very weak at that hour.

The following readers reported stations in the above group: Smart, Moore, Perkins, Condon, Gaden, Lee.

INDIA AND ASIA

As the Asiatic situation is changing from day to day, all references to these stations are, of course, subject to their still being on the air. Stations under Japanese control will be listed under old call letters for ease in identification.

VUD2.—6130kc., 48.94m., Delhi, India. At midnight this Indian is one of the loudest stations on the band.

VUD3.—11,830kc., 25.36m. Same location. Another loud Delhi station nightly from around 10.30 pm.

VUD3.—15,290kc., 19.62m. Same location. This outlet is heard at night from about 5.30 pm, but is not very good.

VUD4.—9590kc., 31.28m. Same location. The loudest of the Indians and gives news in English at 11.30 pm. The above call letters are as given in the official All India Radio list.

XGOY.—11,925kc., 25.16m., Chungking, China. This old regular has now changed frequency slightly and is still heard around 9 pm.

XGOY.—5950kc., 50.42m. Same location. Comes in well both in morning at 7 am and also with the news at 11.30 pm.

XGOY.—9625kc., 31.17m. Same location. Another of the Chungking stations heard with news in English at 1 am.

XGOX.—15,200kc., 19.74m. Same location. News in English from this one nightly at 8.30 pm.

XGOA.—9720kc., 30.86m. Same location. Can be heard any night from about 10 pm or sometimes later.

XPSA.—8465kc., 35.44m., Kweiyang. A regular station every night but is never interesting.

XGOI.—9665kc., 31.04m., Shanghai. Quite good station at night and gives news in English at 11.15 pm.

XGRS.—11,640kc., 25.77m. Same location. This pro-German station is good strength nightly and plenty of English is heard.

XMHA.—11,855kc., 25.3m. Same location. A fairly good station except for interference from the German DJP.

XIRS.—11,980kc., 25.04m. Same location. The Italian station is often very loud around 11 pm and later.

FFZ.—12,060kc., 24.88m. Same location. One of the most consistent Shanghai stations and comes in well nightly.

XGAP.—6100kc., 49.18m., Peking. Heard from about 11 pm and then gives programme from midnight till 1 am.

XLMA.—9350kc., 32.09m., China. Comes in on some nights but quality is very poor indeed.

XGOK.—11,650kc., 25.75m., Canton. Not a regular station now but is sometimes heard at 11 pm.

MTCY.—11,775kc., 25.48m., Hsinking, Manchukuo. Good strength at 5.15 pm, when announcements in English are heard.

MTCY.—9545kc., 31.43m. Same location. Can be logged every day with programme in English from 8 till 9 am.

WHO'S WHO IN SHORT-WAVE BROADCASTING

CHNX, HALIFAX, N.S., CANADA

Frequency, 6130kc, 48.94m. Power, 500 watts.

Operating schedule, 11 pm till 2 pm (Sundays till 2.30 pm).

Standard time, 14 hours behind E.A.S.T.

Distance from Sydney, approximately 9000 miles.

Postal address, Maritime Broadcasting Co. Ltd., Halifax, NS, Canada.

Identification. Plays "The Maple Leaf for Ever" when signing on, relays CHNS and uses four chimes.

Verification details. This is a very prompt station in replying to reports, and sends a very attractive card now, showing call letters.

VONG, ST. JOHN'S, NEWFOUNDLAND

Frequency, 9475kc, 31.67m. Power 300 watts.

Operating schedule, 10.30 pm till 6.30 am.

Standard time, 14 hours behind E.A.S.T.

Distance from Sydney, approximately 9600 miles.

Postal address, Broadcasting Corporation of Newfoundland, PO Box E5372, St. John's, Newfoundland.

Identification. Announces as Broadcasting Corporation of Newfoundland, and rebroadcasts VONF.

Verification details. Their card is very attractive, showing a map of Newfoundland in blue, call letters being in buff superimposed.

TILS, SAN JOSE, COSTA RICA

Frequency, 6165kc, 48.66m. Power 2kw.

Operating schedule, 10 pm till 12.30 am, 3 am till 5.30 am, 9 am till 2 pm (Sundays till 5pm sometimes).

Standard time, 16 hours behind E.A.S.T.

Distance from Sydney, approximately 7400 miles.

Postal Address, "Radioemisors Para Ti," Apartado 3, San Jose, Costa Rica.

Identification. Opens programme with "Stars and Stripes" march and announcement in Spanish, "Radio Para Ti."

Verification details. According to American magazines is supposed to verify, but have never heard of one reaching Australia.

MTCY.—6125kc., 48.98m. Same location. This is the loudest of the Hsinking stations but no English is heard.
Radio Saigon.—10,420kc., 29.29m., Saigon, FIC. Great signal every night and news in English is heard at 10.30 pm.
Radio Saigon.—6188kc., 48.48m. Same location. This outlet comes on the air at 11 pm and is very loud indeed at most locations.
CR8AA.—6250kc., 48.00m., Macao, Portuguese China. Seems to have settled down on this frequency now and heard nightly.
HSP5.—11,715kc., 25.61m., Bangkok, Thailand. Seems to be giving more Western type music now and easily heard about 11 p.m.
Freedom Radio.—9645kc., 31.1m., Philippine Islands. This interesting station is heard well with the news at 9.30 pm nightly.
KZRC.—6105kc., 49.14m., Cebu, PI. Still carrying on with their normal programme nightly.
KZRF.—6140kc., 48.86m., Manila, PI. Now under Jap control and heard every night with occasional talks in English.
KZRH.—9640kc., 31.12m. Same location. Another of the Philippine now operated by the Japanese and heard nightly.
KZRM.—9570kc., 31.35m. Same location. Have only heard this one on a few occasions but it is also, of course, operated by the enemy.
EQB.—6155kc., 48.74m., Teheran, Iran. Get up early to hear this one at its best and English can be heard just before 6 am.
VWY.—9045kc., 33.17m., Kirkee, India. "Radio Francais libr d'Orient" still comes in at good strength at 4.30 am.
ZHP1.—9705kc., 30.9m., Singapore, SS. Has been heard on a few occasions and with English announcer just as before.
ZHJ.—6095kc., 49.21m., Penang, SS. Now operated by the Japs and closes at 10.45 pm.
ZBW3.—9525kc., 31.5m., Hongkong, China. On nightly again, news in English at midnight. New call sounds like JOHK or JOCJ
JZJ.—11,800kc., 25.42m., Tokio, Japan. Very loud station every night around 8 pm.
JVW.—7257kc., 41.34m. Same location. This one can be heard in the mornings at 7 am.
JIE2.—9695kc., 30.95m., Taihoku, Taiwan. News is heard from this one at 10.30 pm.

The following readers reported stations in the above group: Walker, Suleau, Lee, Battis, Gaden, Condon, Smart, Moore, Perkins.

NORTH AMERICA

WGEA.—6190kc., 48.47m., Schenectady, N.Y. Have not heard this one for some nights now but was on at 9.30 pm.
WGEA.—9550kc., 31.41m. Same location. Good on some mornings from 8.30 am and also sometimes heard in afternoons at 3 pm.
WGEA.—15,330kc., 19.57m. Same location. On some mornings this one is audible till closing at 9.15 am. News in English at 8.15 am.
WGEO.—9530kc., 31.48m. Same location. This station is nowhere near as good as a few months ago but sometimes heard in mornings.
WNBI.—11,890kc., 25.23m., New York, N.Y. On the air in the mornings around 6 am and also in afternoons at 4 pm.
WRCA.—9670kc., 31.02m. Same location. Very good station in late afternoon and gives news at 5 pm, also at 7.45 pm.
WCBX.—15,270kc., 19.64m. Same location. Has only been heard weakly at our location.
WCBX.—11,830kc., 25.36m. Same location. This is quite a good station until the Perth transmitter comes on the air.
WCRC.—11,830kc., 25.36m. Same location. This transmitter is often used in the early mornings.
WLWO.—15,250kc., 19.67m., Cincinnati, Ohio. Good station in the very early morning and has also been heard at 5 pm on some days.
WLWO.—11,710kc., 25.62m. Same location. A good station nearly every morning till it closes at 10 am.
WLWO.—9590kc., 31.28m. Same location. On the air from 10.15 am and news can be followed at 11.30 am.
WBOS.—11,870kc., 25.27m., Boston, Mass. Quite a loud station every morning. News is heard at 10 am.
WBOS.—15,210kc., 19.72m. Same location. When it opens at midnight with news it is quite good level.
WRUL.—11,790kc., 25.45m. Same location. At time of writing this one is missing at our location in early morning.
WRUW.—9700kc., 30.93m. Same location. Still being heard at fair level from opening at 7.50 am.
WRUS.—6040kc., 49.67m. Same location. Has weakened a lot and is now practically inaudible in the mornings from opening at 7.50 am.
KGEI.—7250kc., 41.38m., San Francisco, Cal. Very good now at night except when VLQ9 is on the air.
KGEI.—15,330kc., 19.57m. Same location. Comes in fairly well around lunch-time but never particularly good.
KEL.—6860kc., 43.73m., Bolinas, Cal. Carrying the KGEI programme is very good at 10.30 pm.
KEJ.—9010kc., 33.3m. Same location. Another Bolinas transmitter often heard at good strength at 10.30 pm.
KEZ.—10,400kc., 28.85m. Same location. At some locations this one is the best of these relay stations.
KEQ.—7370kc., 40.71m., Kahuku, Hawaii. A new Hawaiian station heard at 11 pm. First reported by Dr. Gaden.
KJE8.—9390kc., 31.95m., Los Angeles, Cal. Terrific strength from this new station with test programmes late at night.
KJE9.—10,750kc., 27.91m. Same location. When it opened at 2 am was the loudest station on any band. See article this month.
WRUW.—11,730kc., 25.58m., Boston, Mass. This station can be heard with Norwegian programme at 9.45 am.
WRUW.—15,350kc., 19.54m. Same location. We were surprised to hear this station at very good strength giving news at 2 am.
WRUL.—17,750kc., 16.9m. Same location. This one was being used in parallel but was not nearly as strong as the 19-metre one.
WCRC.—17,830kc., 16.83m., New York, N.Y. Another surprise logging one morning at 2 am but it was very weak. Opens at midnight.
WNBI.—15,150kc., 19.81m. Still another USA station which is quite loud about 2 am. This one opens at midnight.
WNBI.—17,880kc., 16.78m. This is a new channel which can be heard at 2 am and we think it comes on the air at 1 am.
WNBI.—17,780kc., 16.87m. Good signal from this channel when it opens at midnight in parallel with 15,150kc.
CBFY.—11,705kc., 25.63m., Montreal, Que., Canada. Heard best from about 11.30 pm when it is easily followed.
CFRX.—6070kc., 49.42m., Toronto, Ont. This Canadian is also audible nightly around midnight.
CJCX.—6020kc., 49.83m., Sydney, NS. Still being heard opening at 10.35 pm, when it is fairly good.
XEXA.—6170kc., 48.62m., Mexico City, Mexico. Really good station when it comes on the air at 1 am.
XEWW.—9503kc., 31.57m. Same location. Still the most consistent Mexican, both in late afternoons and also at midnight.
XEQQ.—9680kc., 30.99m. Same location. Have only heard this one around 1 am during the past few weeks.

The following readers reported stations in the above group: Suleau, Moore, Foster, Smart, Walker, Gaden, Lee, Perkins, Condon.

CENTRAL AMERICA AND WEST INDIES

HP5A.—11,700kc., 25.64m., Panama City, Panama. Quite good signal around midnight.
HP5G.—11,780kc., 25.47m. Same location. Now heard opening at midnight. News in English am, preceded by Double Eagle march. March also 12.30 am, preceded by Double Eagle march. March also given after news.
HP5J.—9607kc., 31.23m. Same location. Always a good station from opening at 11 pm.
HH3W.—10,130kc., 29.62m., Port au Prince, Haiti. Can be heard every morning from just before 7 am. Announces in French and Spanish.
HHBM.—9660kc., 31.06m. Same location. Practically impossible to separate this one from XGOI
TIEMC.—11,900kc., 25.21m., San Jose, Costa Rica. Comes in reasonably well nightly from just after 11 pm.
TIJMT.—11,900kc., 25.21m. Same location. Radio America Latina is heard on Sunday afternoons till 5 pm or later.
TIPG.—9620kc., 31.19m. Same location. Still the best of the Costa Ricans and heard well nightly from 11 pm.
TILS.—6165kc., 48.66m. Same location. Opens at 11 pm and gives war news in Spanish.
TIEP.—6696kc., 44.81m. Same location. Still another Costa Rican heard nightly, opening at 11 pm, but never very loud now.
TGWA.—9685kc., 30.98m., Guatemala City, Guatemala. Have only heard this one on Sunday afternoons till just after 4 pm.
TGWA.—15,170kc., 19.78m. Same location. One of the best on the band on a Monday morning only.
HI3C.—6150kc., 48.78., La Romana, Dominican Republic. Listen for this one about 11.15 pm when it opens with a march.
YNRS.—8585kc., 34.95m., Managua, Nicaragua. Improved from last month and nearly always audible from 11 pm or sometimes midnight.
COBC.—9695kc., 30.94m., Havana, Cuba. Notice big change in frequency of this Cuban. Is quite good strength at midnight.
COCQ.—8850kc., 33.9m. Same location. Can be heard in the mornings at 8 am, afternoons at 4 pm, and also around 11 pm.
COCO.—8700kc., 34.48m. Same location. Had a few nights of the snappy advertising programmes but is now not heard till late at night.
COCX.—9270kc., 32.36m. Same location. Another Cuban which is quite good in mornings at 8 am and also from opening at midnight.
COCW.—6330kc., 47.39m. Same location. Now a regular every night from opening at 11 pm, preceded by a few records.
COCH.—9435kc., 31.8m. Same location. Comes in best at night but can sometimes also be heard in the late afternoon.
COCM.—9833kc., 30.51m. Same location. Both in the mornings at 8 am and also at night this station is at enjoyable level.
COCY.—11,740kc., 25.55m. Same location. Still another of these stations heard in mornings and also in afternoons at 4 pm.
COBZ.—9025kc., 33.24m. Same location. Opens weakly just before midnight, but it requires careful tuning to locate it.
COK.—11,616kc., 25.82m. Same location. Usually heard in the afternoon but some listeners have logged it at 7.45 am.
COHI.—6455kc., 46.48m., Santa Clara, Cuba. Comes on the air at 11 pm, when it can easily be followed for about an hour.

The following readers reported stations in the above group: Walker, Foster, Fleming, Condon, Moore.

SOUTH AMERICA

HJCX.—6018kc., 49.85m., Bogota, Colombia. Again being heard opening at 11 pm with Indian Love Call.
HCQRX.—5972kc., 50.23m., Quito, Ecuador. Very faint, but can just be heard opening at 10.45 pm.
HCJB.—12,460kc., 24.08m. Same location. Has been heard quite often at good strength from opening at 11 pm.
CB960.—9600kc., 31.25m., Santiago, Chile. Heard once or twice on a Sunday, closing at 4 pm.
CB970.—9735kc., 30.82m., Valparaiso, Chile. Again being heard on some nights opening at 10.30 pm.
CB1180.—11,975kc., 25.05m., Santiago, Chile. This is the best Chile station nightly at 10.30 pm.
OAX4J.—9340kc., 32.12m., Lima, Peru. This is a good station now at night from opening at midnight.
OAX4G.—6190kc., 48.47m. Same location. Becoming stronger now on Sunday afternoons till closing at 4.30 pm.

NEW STATION LOGGINGS

THE following new stations have all been definitely heard and identified at our location since our last issue. Where call letters are not as yet known, station is listed under its location.

Kc.	Metres	Call	Location
7185	41.75	GRK	Daventry, England.
7250	41.38	GRM	Daventry, England.
7370	40.71	KEQ	Kahuku, Hawaii.
9390	31.95	KJE8	Los Angeles, Cal., USA.
9645	31.10	"Freedom Radio"	Philippine Islands.
10,750	27.91	KJE9	Los Angeles, Cal., USA.
11,760	25.51	DXR	Berlin, Germany.
11,945	25.12	2RO	Rome, Italy.
15,450	19.42	GRD	Daventry, England.
17,830	16.83	WCRC	New York, NY, USA.
17,880	16.78	WNBI	New York, NY, USA.

CXA8.—9640kc., 31.12m., Colonia, Uruguay. On two mornings has been heard at 7 am with quite a fair signal.

PRE9.—6105kc., 49.14m., Fortaleza, Brazil. Can be heard now in the mornings opening at 8 am, but soon fades out.

AFRICA

ZOY.—6002kc., 49.98m., Accra, Gold Coast. Slightly louder now in the mornings at 6 am, when static is not too troublesome.

ZRH.—6007kc., 49.95m., Johannesburg, South Africa. Quite good in mornings opening at 2 am and also heard at 7 am at fair strength.

ZRK.—6097kc., 49.2m., Capetown, South Africa. This African station is now audible and the BBC news can be followed at 7.45 am.

ZNB.—5900kc., 50.85m., Mafeking, British Bechuanaland. Audible at 6.30 am and also relays the BBC news at 7.45 am.

SUX.—7865kc., 38.15m., Cairo, Egypt. This station is again being heard with programme in Arabic till closing with march at 7 am.

SUP2.—6320kc., 47.47m. Same location. Another Egyptian station which is excellent strength in the mornings from 3.30 am till 4 am.

Radio Cairo.—5980kc., 50.17m. Same location. Unfortunately this station is now interfered with by Morse but news still at 7 am.

Radio Addis Ababa.—9625kc., 31.17m., Addis Ababa, Ethiopia. On the mornings when we have been up can still be heard at 2.30 am.

Radio Tananarive.—6063kc., 49.48m., Tananarive, Madagascar. Very loud station in the mornings at 2.30 am; sometimes till 3.30 am.

CR6RA.—9470kc., 31.68m., Luanda, Angola, Portuguese West Africa. This one can still be heard in the mornings till closing at 8 am.

CR7AA.—6035kc., 49.73m., Lourenco Marques, Mozambique. This one has been heard with same programme as CR7BE in mornings at 7.30 am.

CR7BE.—9840kc., 30.49m. Same location. A really excellent station every morning and quite loud till well after 8 am.

FZI.—11,970kc., 25.06m., Brazzaville, Free French Africa. Still being heard in the mornings at 6.45:, with news in English.

OPM.—10,140kc., 29.59m., Leopoldville, Belgian Congo. Rather hard to separate from HH3W, but always there till 6.45 am.

VQ7LO.—6060kc., 49.5m., Nairobi, Kenya Colony. Has been heard giving news at 5 am, but has lost a lot of its strength lately.

TPZ.—12,120kc., 24.75m., Algiers, Algeria. Good station both in the mornings at 8 am and also late afternoons from 6.45 pm.

TPZ2.—8960kc., 33.48m. Same location. This station carries the same programme as TPZ and is always very much louder.

CNR.—8035kc., 37.34m., Rabat, Morocco. Never very loud at our location but can just be logged in the mornings at 7 am.

FGA.—9410kc., 31.88m., Dakar, Senegal. After a long absence has again been logged, opening at 6.15 am, but is weak at that time.

ZRO.—9755kc., 30.75m., Durban, South Africa. This little-heard station is now audible in the mornings at 2 am.

The following readers reported stations in the above group: Walker, Flemin, Suleau, Condon, Smart.

AUSTRALIA AND OCEANIA

VLY.—9430kc., 31.81m., Sydney. Heard at terrific strength relaying programme of VUD4, Delhi, to San Francisco.

VLG3.—11,710kc., 25.62m., Lyndhurst. Excellent strength in afternoon till closing at 4.40 pm.

VLR.—9580kc., 31.32m. National programme 6.45 pm till 11.30 pm.

VLR3.—11,880kc., 25.25m. National programme, noon till 6.15 pm.

VLR8.—11,760kc., 25.51m. National programme, 6.30 am till 10.15 am.

VLG2.—9540kc., 31.45m. To N. America 10.25 till 11.10 pm, to S.E. Asia 12.15 am till 2 am.

VLG5.—11,880kc., 25.25m. National programme 8.30 till 10 pm.

VLG7.—15,160kc., 19.79m. National programme 6.30 till 8.10 am, noon till 3.40 pm, and to AIF in SW Pacific from 6.25 till 7 pm. Finally closes at 8.15 pm.

The following readers reported stations in the above group: Condon, Gaden, Lee, Walker, Smart, Perkins.

MISCELLANEOUS

OIX1.—6120kc., 49.02m., Lahti, Finland. Still coming in well from opening at 2 am and also audible at 6 am.

OIX2.—9500kc., 31.58m. Same location. This station has also been heard closing at 7 pm as well as in the mornings at 6.30 am.

OIX3.—11,780kc., 25.47m. Same location. Comes in fairly well some mornings at 7 and has also been heard at 6.45 pm.

OIX5.—17,800kc., 16.84m. Same location. Only heard infrequently now and never at any great strength.

HER3.—6165kc., 48.66m., Schwarzenbourg, Switzerland. This is still one of the best stations on this band in mornings around 7 am.

HER5.—11,865kc., 25.28m. Same location. This outlet can always be heard on a Sunday night opening at midnight.

HVJ.—11,740kc., 25.55m., Vatican City. Excellent strength when it opens at 6 pm in POW session.

HVJ.—6005kc., 49.96m. Same location. Still rather irregular in mornings at 6.15 am and we cannot determine its schedule.

HVJ.—9660kc., 31.06m. Same location. Very good in early morning at 3 am if you are ever up at that time.

HVJ.—15,120kc., 19.84m. Same location. Quite a good station when it opens at 8.30 pm on a Sunday, but strength soon fades.

CSW6.—11,040kc., 27.17m., Lisbon, Portgual. A really top-hole station and gives excellent musical numbers in morning at 6 am.

CSW7.—9740kc., 30.8m. Same location. Not nearly as good as CSW6, but can sometimes be heard around 9.30 am.

CS2WD.—6200kc., 48.39m. Same location. When Paris is not using same frequency, can be logged at 7 am.

Emissora Nacional.—7305kc., 41.07m., Ponta Delgada, Azores. Still heard every morning from 7 till 8 am.

Christian Peace Movement.—9410kc., 31.88m. Still putting over hymns, &c., from 6.45 am till 6.55 am. Sometimes mixed with Dakar.

Radio Mediteranía.—7035kc., 42.66m., Valencia, Spain. Very good signal every morning from opening at 7 am.

Radio Bucharest.—9260kc., 32.4m., Bucharest, Rumania. Has improved since last month and news in English can be followed at 7.50 am.

SPW.—13,635kc., 22.0m., Warsaw, Poland. This station has been heard with musical programme at 2 am, when strength was very good.

TAP.—9465kc., 31.7m., Ankara, Turkey. Still a very good station in mornings, gives talk in English at 6.15 am.

TAQ.—15,195kc., 19.74m. Same location. Still being heard on some nights around 10.30 pm.

SBP.—11,705kc., 25.63m., Motala, Sweden. This station is very good every Sunday night at 10.45 pm.

YUB.—6100kc., 49.18m., Belgrade, Yugoslavia. Excellent now in the mornings and gives French talk at 7.45 am.

LKQ.—11,735kc., 25.57m., Oslo, Norway. Has only been heard on a few occasions in the later afternoon.

LLH.—9645kc., 31.1m. Same location. This station was heard closing with announcement in English at 2 pm.

PCJ.—9590kc., 31.28m., Huizen, Holland. On some mornings this one is heard opening at 8.50 am, when strength is fair.

PCJ2.—15,220kc., 19.71m. Same location. Quite a loud signal, but greatly interfered with by Morse.

Paris.—6200kc., 48.39m., Paris, France. Very loud station in early mornings when it is on the air.

Paris.—9520kc., 31.5m. Quite loud signals from this one at 6 pm.

Paris.—11,880kc., 25.25m. Still heard in mornings at 6.45 am.

Paris.—11,845kc., 25.33m. Opens at good strength some days at 6.45 pm.

Paris.—15,245kc., 19.69m. Heard some nights at 6.30 pm.

Paris.—17,850kc., 16.8m. Good strength on some nights at 11 pm.

Moscow.—15,230kc., 19.7m. English heard from this one at 10.10 am

Moscow.—12,060kc., 24.88m. English heard from this one at 11.45 pm.

Moscow.—10,040kc., 29.88m. English heard from this one at 12.30 am.

2RO3.—9630kc., 31.15m. Comes in well in afternoons at 4 pm and also in mornings at 7 am.

2RO4.—11,810kc., 25.4m., Rome. Good in afternoons till about 6 pm.

2RO6.—15,300kc., 19.61c. Good strength in late afternoon.

2RO9.—9670kc., 31.02m. This is a morning station heard at 7 am.

2RO11.—7220kc., 41.55m. Another early morning station heard at 7 am.

2RO15.—11,760kc., 25.51m. Comes in well in very early hours.

2RO8.—17,820kc., 16.84m. Still being heard at 11 pm.

2RO20.—17,780kc., 16.87m. Used in parallel with 2RO8 at same time.

IRF.—9830kc., 30.52m. Heard at 7 am with programme French and Italian.

2RO.—11,945kc., 25.12m. New station heard in the mornings in parallel with 2RO4.

DHE2A.—6010kc., 49.92m., Prague, Bohemia. Has been heard in late afternoons till closing at 5.45 pm.

DHE4A.—11,840kc., 25.34m. Same location. Still coming in every morning around 7.30 am.

DXR.—11,760kc., 25.51m., Berlin, Germany. New German outlet comes in well at 7 am and can also be heard at 5 pm.

DXP.—6030kc., 49.73m. Loud station at 7 am.

DXX.—6140kc., 48.86m. News in English is loud at 6.30 am.

DXJ.—7240kc., 41.44m. Heard well in mornings at 7 am.

DJR.—15,340kc., 19.56m. Still very loud station at night.

DJW.—9650kc., 31.09m. Good strength in late afternoons.

DJH.—17,845kc., 16.81c. Holding up well late at night.

DJC.—6020kc., 49.83m. Good strength in mornings at 7 am.

DZD.—10,543kc., 28.45m. Another loud station in early morning.

DJL.—15,110kc., 19.85m. English heard at 10.30 and 11.30 pm.

The following readers reported stations in the above group: Fleming, Lee, Condon, Walker, Suleau, Gaden.

SCOOP—

CAROLINE ISLAND STATIONS NOW ON THE AIR

WE have just been officially advised from the United States of America that the Japanese are now operating a short wave station in Palao, Caroline Islands, and are at present using two frequencies, 9565kc., 31.37m., and 11,740 kc., 25.55m.

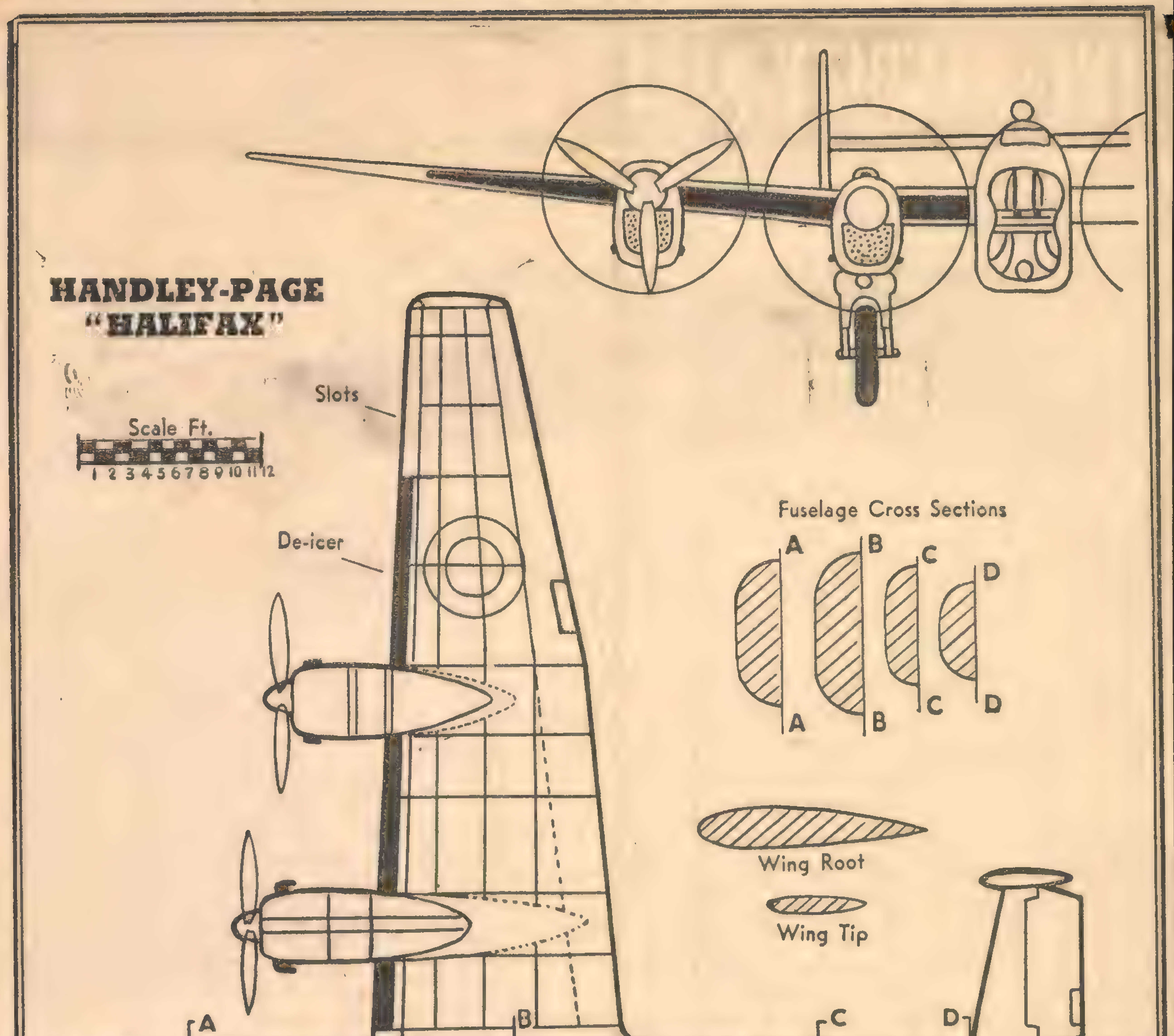
We have all been hearing these stations for some weeks now, and were under the impression that they were just two more outlets of the regular transmitter in Tokio, Japan, but it now appears that they were actually the new transmitter in these Pacific Islands.

The power of this new station is 10kw., which accounts for the strong signal which is heard in this country.

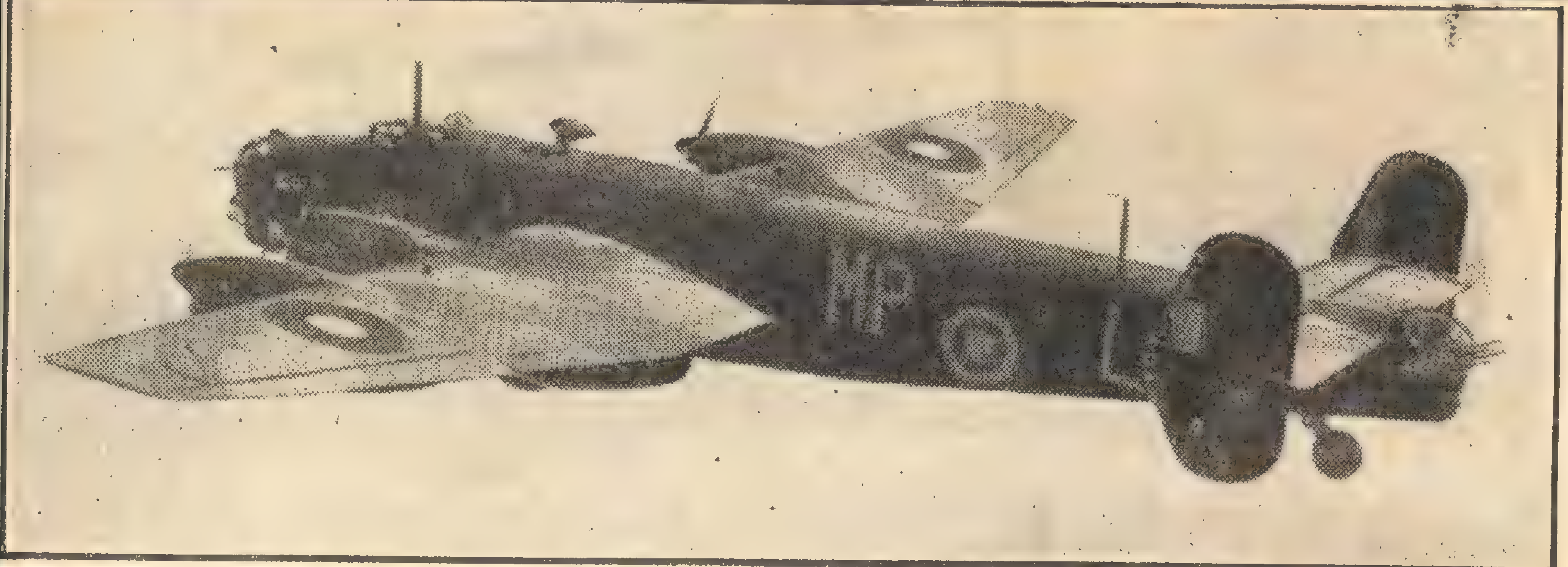
60 FIRST AUSTRALIAN VERIFICATIONS

SINCE last month's issue we have increased our list of First Australian verifications to 60, as we have recently received another letter from CXA2, "Radio Continental" in Montevideo, Uruguay, advising that our reports were the first they had received for both their 6000kc. and 9570kc. transmissions. The actual verifications were received a few months ago.

By the same mail we also received a very nice letter from the general manager of the Broadcasting Corporation of Newfoundland, a Mr. W. F. Galgay, wishing us a Happy Christmas and thanking us for the first report they had received from Australia on their station VONG. As readers will remember, we have already received their card, which was actually sent at a later date than the above letter.


HANDLEY-PAGE
"HALIFAX"
Slots
Scale Ft.
1 2 3 4 5 6 7 8 9 10 11 12
De-icer
Fuselage Cross Sections
A
B
C
D
Wing Root
Wing Tip
Red
White
Blue
Yellow

THE HANDLEY-PAGE "HALIFAX" BOMBER



The Handley-Page Halifax bomber in full flight. Its four Rolls-Royce motors give it a top speed of 310 mph and a cruising speed of 278 mph. It has plenty of range and carries a large bomb load. Note the four guns in the turret aft.

One of the latest English bombers, of which some performance figures and protographs have just been released, is the Handley-Page Halifax. Planes of this type, together with Short Stirling bombers — another four-engined giant — have been blasting Germany's communications, factories and supplies for some time.

THE Halifax bomber is produced by Handley-Page Ltd., of Cricklewood, a suburb of London. The Handley-Page Company is the oldest incorporated aircraft firm in England and many readers will remember its fame in the first World War when it turned out huge bi-plane bombers used extensively in raids over Germany.

Few know, however, that these bombers and their variations were used up till 1930 in the RAF, and were in many places being used right up till the start of the present conflict. You can see, therefore, just how reliable these machines were.

AERODYNAMIC RESEARCH

Handley-Page Ltd. have always been extremely keen in aerodynamic research and this has played an important part in their development. They were one of the first firms to make available to the aircraft industry many new developments, the best known of which was the Handley-Page slot. Such bombers as the Hampden and Hereford have achieved notable successes in action with the Bomber Command.

Until quite recently, British bombers were unable to fly to Berlin and beyond in great numbers. Now, however, with the advent of the Stirling, Halifax, Flying Fortress, all large four-engined planes, the war is being carried more and more into enemy skies, and England is beginning to repay with interest the damage done to her own towns by the Luftwaffe in the earlier stages of the war.

People often ask what delayed the development of the four-engined, long-range British bomber. It may be of interest to note that the plans for both the Stirling and Halifax were completed over three years ago, although they have only been in actual production for a little over a year. However, as soon as the first batch were rushed off the production line, they were sent into action and have since been proving their worth and striking power.

BRITISH AND AMERICAN BOMBERS

One noticeable feature is that the British monsters bear little or no resemblance to the large American Fortresses or Liberators. In fact, the latest American type, the B-170, is now equipped with a rear gunner's turret right under the fin. It seems that the Americans have learnt something from the British!

by John French

In the construction of the Halifax, all kinds of materials are used, and at first glance its rapid mass production might seem difficult. However, like most British machines of today, it is built in sections, each section being bolted firmly to the next.

The fuselage is built in three sections. The forward section is covered with aluminium alloy sheet, riveted in position. The centre portion, to which the wings are attached, is built up on a framework of bolted chrome-molybdenum steel tubing. The after section is a framework of welded steel tubing. Both centre and aft sections are covered with a light wooden secondary structure, over which is an exterior fabric covering.

THE WINGS

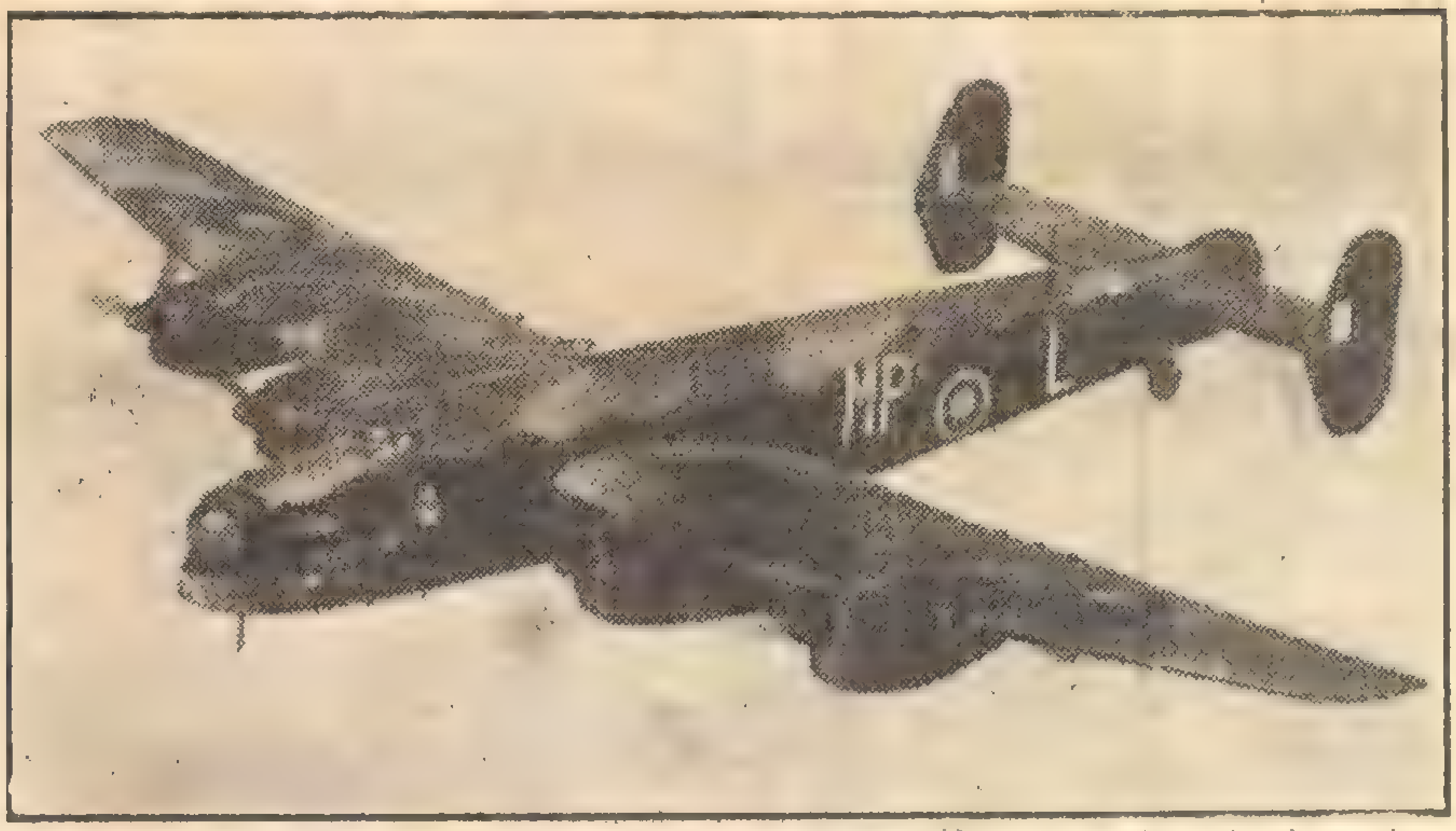
The wings are built in five sections. The centre section and two inner panels are built up on a conventional alloy rib and stringers framework. The spar is a single built-up girder with upper and lower nose flanges suitably reinforced with ribs and stringers, together forming a torsionally-stiff "D" section spar. The extreme outer panels accommodate the slots in the leading edge of the wing.

The Halifax is fitted with Handley-Page automatic slots, which move forward, reducing the chances of a stall. Handley-Page slotted ailerons are also fitted.

TAIL ASSEMBLY

The tail surface is the twin rudder type, the horizontal stabiliser resting atop the rear fuselage, and the vertical fins being attached to the extremities. Both rudders and elevator are duralumininium constructed and fabric covered. All control surfaces are fitted with control tabs.

GERMAN INDUSTRIES WILL SUFFER



Another view of the Handley-Page Halifax bomber. The underneath surfaces of the plane illustrated are painted a deep blue or black and the upper surfaces are fully camouflaged. Compare this photo with the one below.

The problem of the undercarriage was treated as a very special one, and when it finally went into production, special balloon tyres—the largest ever made in England—were used. The wheels are supported on heavy "U" shaped trusses built up on a box spar type of structure. Each wheel has two shock absorbers. The tail wheel is also of the balloon type, but is not retractable like the two main wheels.

FOUR R-R ENGINES

Four Rolls-Royce Merlin engines, type XI., mounted in individual wing nacelles, drive the Halifax. The latest figures available on this type of engine gave its normal rating at sea level as 1300 h.p. and 1145 h.p. at 16,750 feet. However, later Merlins are rated at 2040 h.p.

In the Halifax, each nacelle carries its own individual oil tank, having capacity of 41 gallons, giving a total capacity of 164 gallons. The fuel system consists of four major tanks, and their reserve supply tanks, with a total capacity of 1620 gallons. These major tanks are carried within the centre section and each inner wing panel. Reserve tanks are in each inner panel trailing edge. Both oil and fuel tanks are of bullet-proof composite construction.

Propellers are de Havilland constant speed, manufactured under licence from the Hamilton Standard Co. of America. Large spinners are fitted to each.

CREW OF TWELVE

The crew of 12 may, at first glance, appear very large, although as few as four may operate the machine successfully. There is a gunner in a power operated turret in the nose, and below him the bombardier. Immediately behind the bombardier, on the lower deck, is the navigation officer or radio operator. Immediately above are the pilot and second pilot in the control cabin. Aft of this is the navigation officer's room, with a glassed-in cupola through which sights may be taken of the stars.

Then come the bomb racks, aft of which are situated a chief mechanic and electrician, facing a variety of dials and instruments. An assistant is also carried here, whose job it is to look after guns, supply of ammunition and oxygen. In the extreme aft section is the rear gunner.

Provision has also been made for the transport of a full squad of eight men within the rear compartment. Quarters may be installed aft of the pilot for the observer or for the commander of the ship or squadron.

The Halifax has complete oxygen equipment for the entire crew, each member having a separate supply. Complete de-icing equipment is also carried and provision has been made for installation of floating compartments, a dinghy of the inflatable type, messag[e] pick-up gear, two cameras, one fixe[d] type and the other of the panorami[c] mapping type, landing lights, signa[l] lights and identification lights.

Bomb loads are carried completel[y] within the fuselage and a total weigh[t] of up to eleven thousand pounds ma[y] be carried. Bombs are released i[n] "sticks" or a number at a time.

ARMAMENT

The armament aboard a Halifa[x] varies somewhat. The armament o[n] the earlier types was a total of fou[r] 50-calibre Brownings mounted in fron[t] and rear turrets. However, more gun[s] were found necessary, so the lates[t] versions of the Halifax have four gun[s] to a turret, making eight in all. Th[e] installation is similar to that used i[n] a Boulton Paul Defiant.

Recently the newly-developed twi[n] cannon (37 min.) power operated turre[t] has been fitted to the short Stirling so that it will probably be fitted to th[e] Halifax as well.

DIMENSIONS &c.

The dimensions are as follows:—

Wing span	99ft. 4in.
Length	70ft. 9in.
Height	22ft. 7½in
Span of tail plane	26ft. 2in.
Diameter of wheels	5ft. 5in.
Weight loaded	53,450lb.
Weight empty	35,600lb.

Top speed of the Halifax is 310 mph and cruising 278 mph. Landing speed i[s] 72 mph, and the cruising range is 360[0] miles. The latter may be increased b[y] the installation of extra tanks, to neare[r] 5000.

Although, as yet, there are comparatively few in service, a recent Air Ministry statement said that 1000 of thes[e] super bombers would be in service b[y] the midsummer of 1942.

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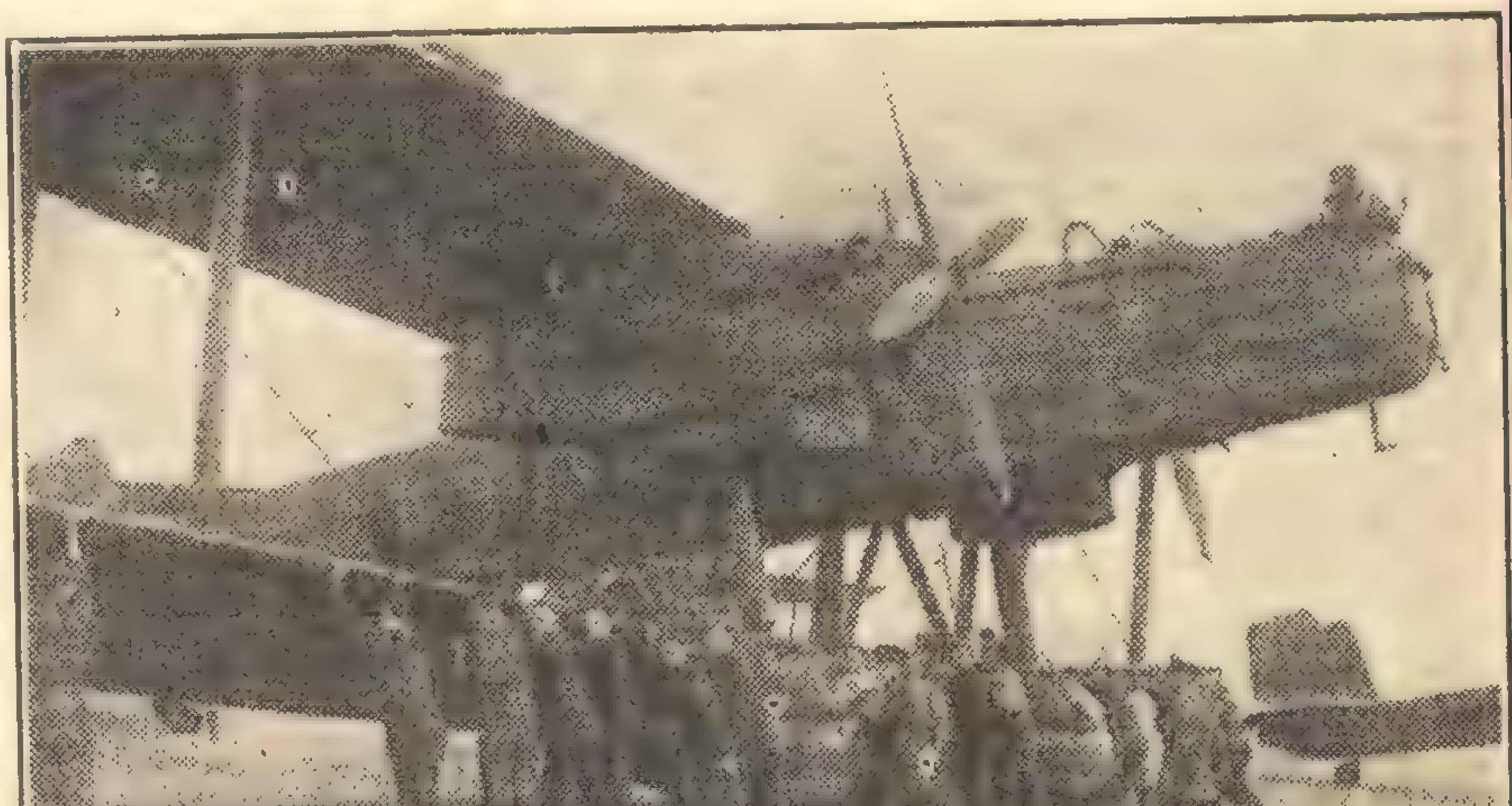
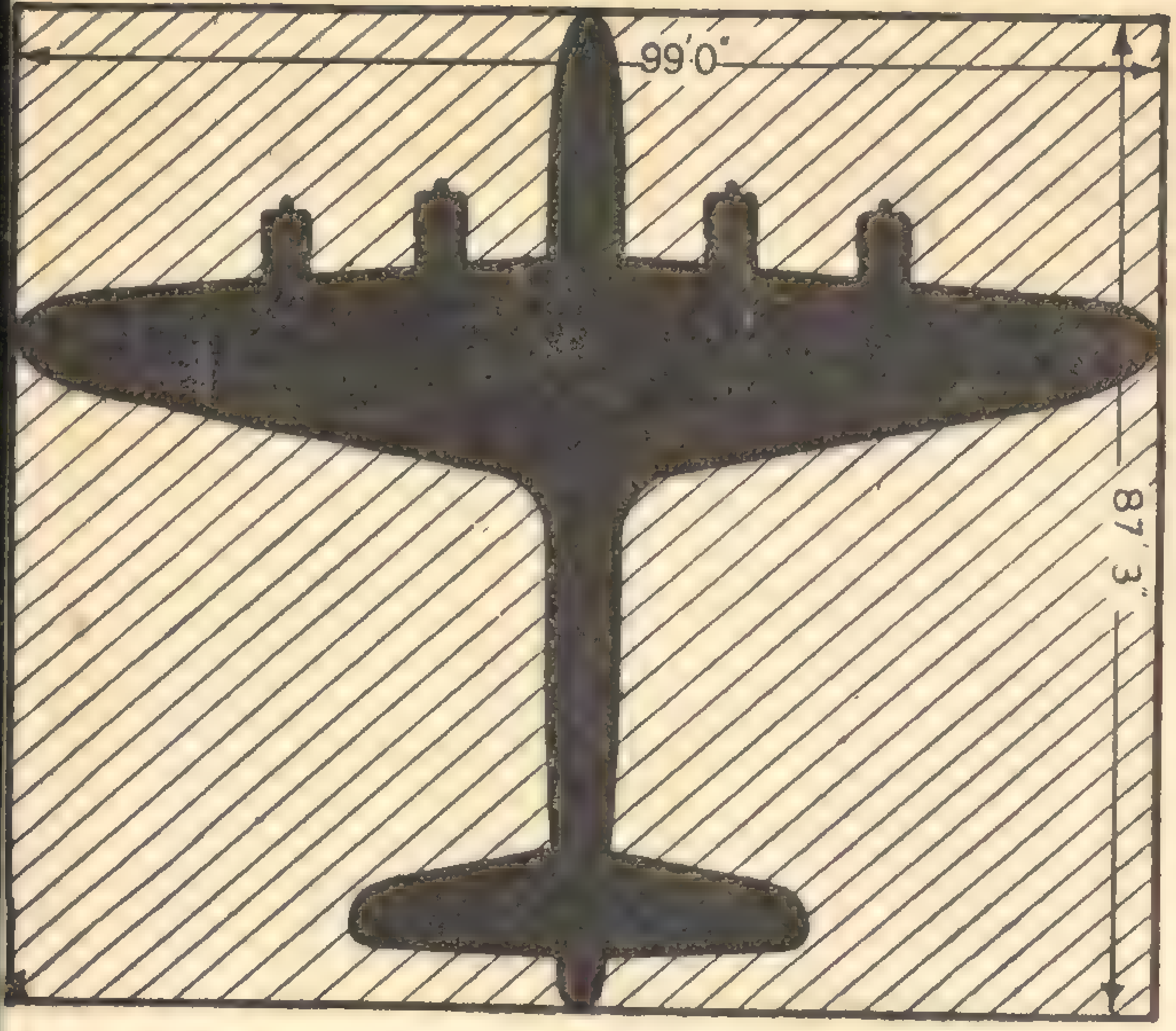
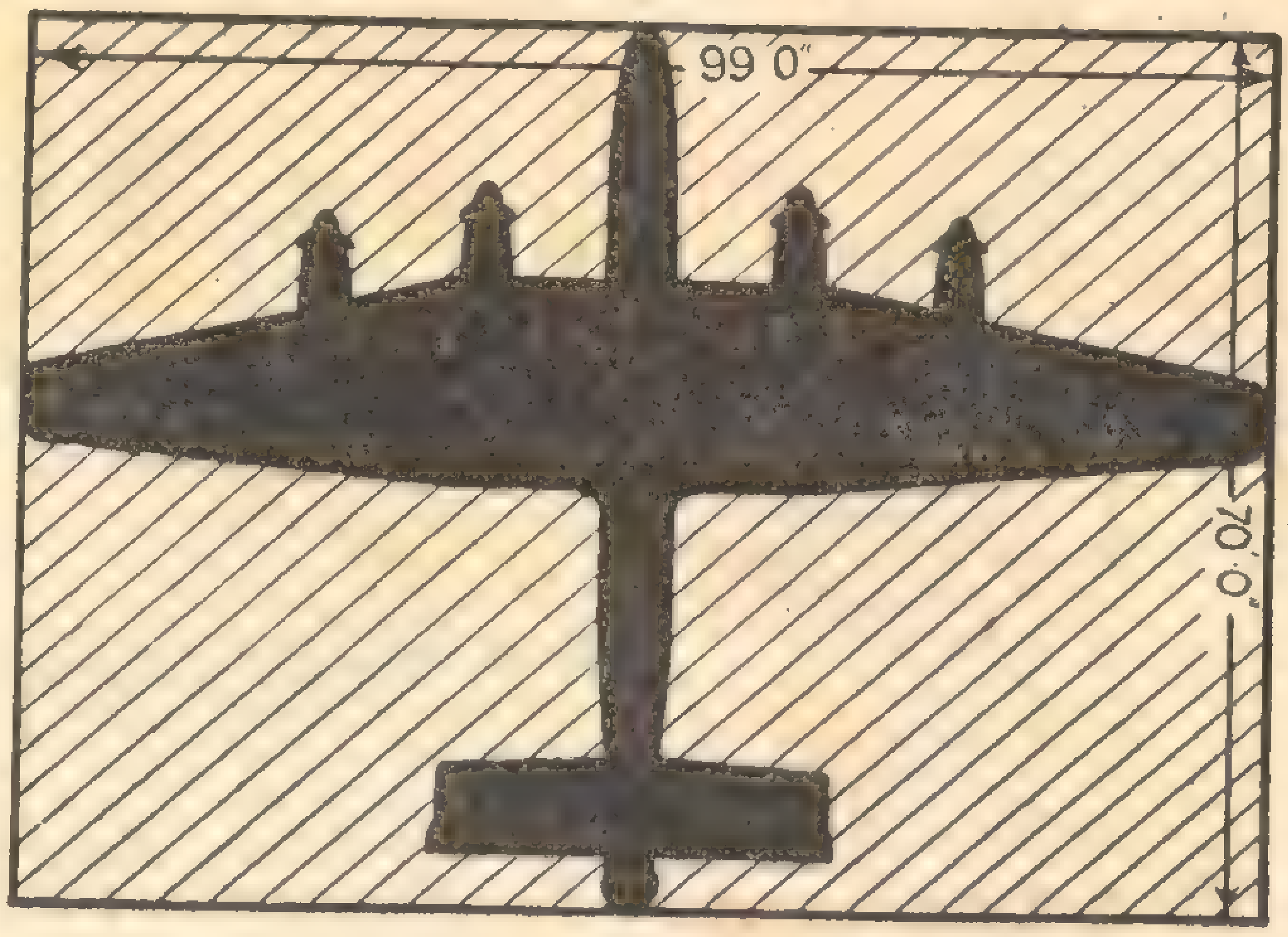
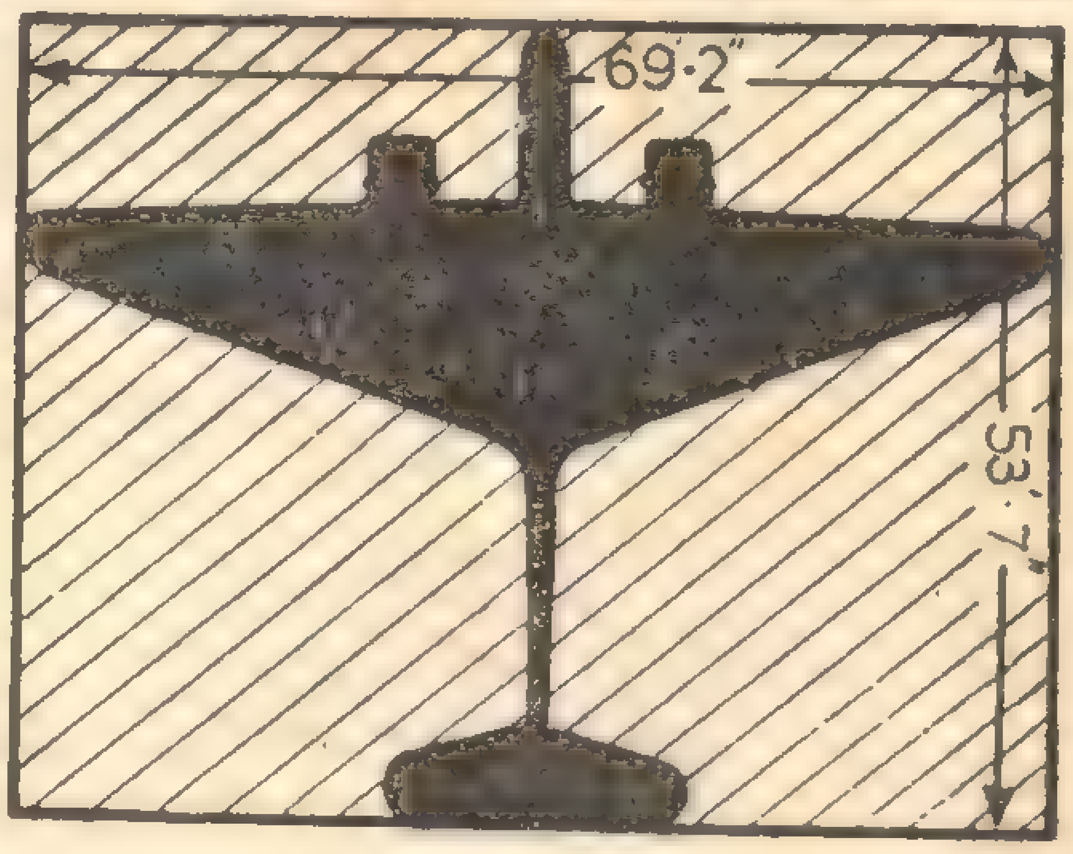


The last few years have seen amazing changes in airplane design. This Heyford night bomber was one of many similar planes used in full-scale aerial manoeuvres over Britain in the latter half of 1937. Note the comparatively small size, the fixed undercarriage, the network of struts and bracing wires, the makeshift streamlining of the engines and the absence of spinners on the propellers.

AREA OF BRITAIN'S LATEST BOMBERS COMPARED







An excellent idea of the size of Britain's new bombers can be gained from these silhouettes. On the left is the Short Stirling, on the upper right is the Handley-Page Halifax and on the lower right the more conventional Handley-Page Hampden. Note the greater length of the Stirling as compared to the Halifax. The new American Douglas B-19, with its wing span of 212 feet, would dwarf even the Stirling.

BUILDING A MODEL

To build a successful model of this type, extreme care must be taken in all stages because of the four engines and large wingspread as compared to the fuselage. Build the fuselage first by cutting a block of the correct size to top and side views. Round off the edges until the correct cross section is obtained and then sandpaper the fuselage down carefully until it is completely smooth.

Next, build the tail surfaces and connect the assembled tail section to the rear fuselage in the position marked on the plan. Finally, make the two wings using sandpaper and knife to give the correct contours. Do not cut the wing where the engine is to be installed.

Make the four-engine nacelles and cut a slot in them at one point where they will go on to the wing. Also cut a slot in the wing. Do not in either case cut the slot the full depth. Cut each one half the required distance and, when fitted, the nacelle will fit very tightly.

Now connect the wings to the fuselage, and the undercarriage and farings, give a final sandpaper with the finest possible paper, dust the model thoroughly and then go all over the model with two or three coats of balsa sealer or banana oil. Sand between each coat. The model is now ready for painting.

The standard color of the Halifax is either all jet black relieved by the color circles and squadron markings, or camouflaged. Top surfaces are jet black or dark blue, undersides with insignia and squadron markings.

THESE PLANES WILL HARASS GERMANY

(Continued from Page 12)

sketch. This machine is built by Short Bros., whose Sunderland flying-boats have won acclaim for their magnificent over-water patrol work. The Stirling is on the same general lines, but is, of course, a land-based machine. Many squadrons are now in service with the RAF.

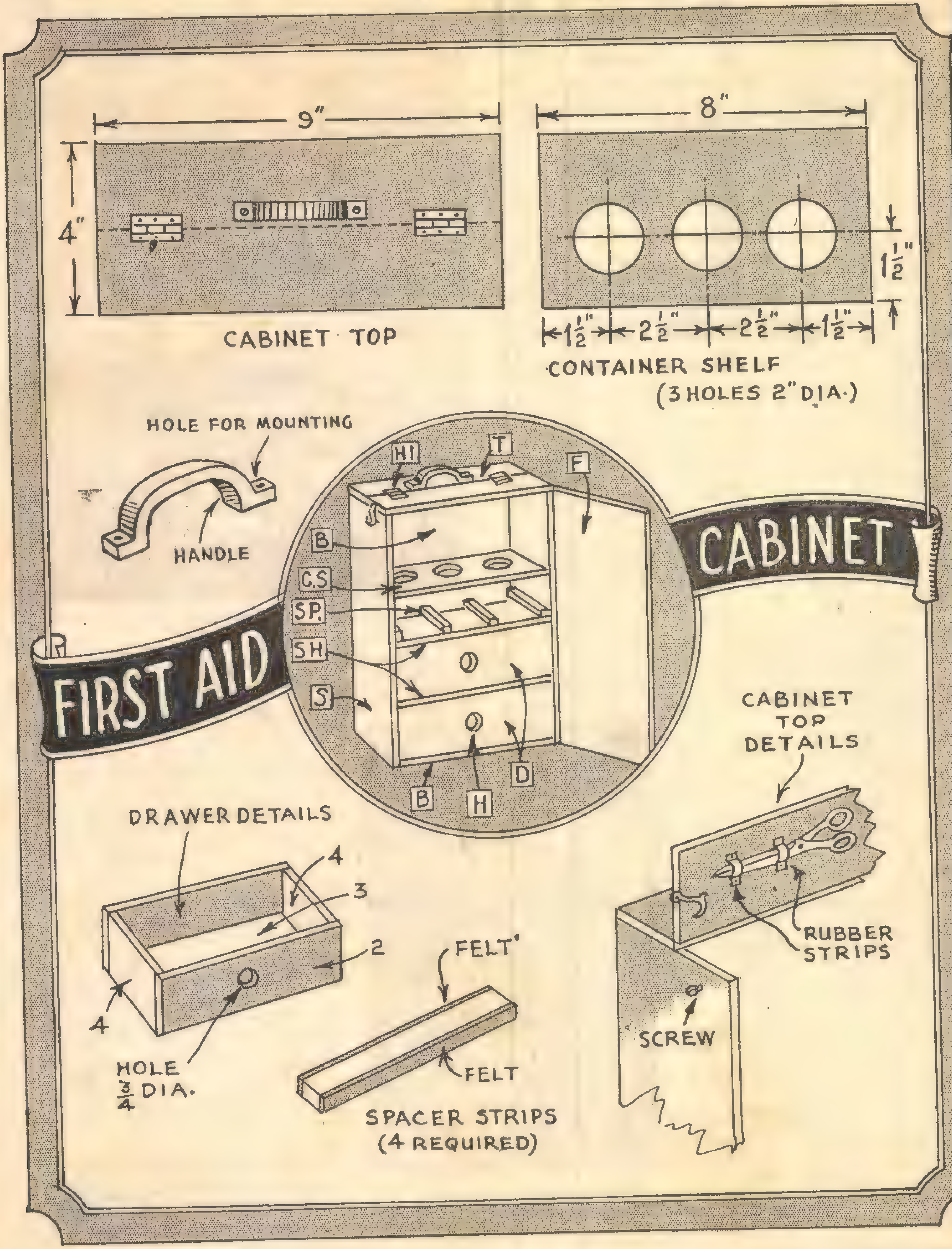
The Stirling has been described as being able to carry four tons of bombs from England to Berlin at a speed of more than 300 mph. The plane is believed to be the only bomber in large-scale production in the world to-day that can carry four 4000lb. bombs at a time.

Power is derived from four 14-cylinder radial air-cooled engines each developing 1400 horse-power. As with the Halifax, the Stirling has a forward gunner's turret in the nose, with the bomb-aimer's position below, and the cabin above and further back. There is good visibility from all these points. The rear-gunner's turret is below and behind the gigantic single fin.

The huge landing wheels retract into the wings.

The Stirling is built to grand proportions—it has a wing-span of 99ft. and a length of over 87ft. When the machine is on the ground the height to the top of the pilot's cabin is 23ft.

PLANS FOR THE FIRST AID CHEST



FIRST AID CABINET FOR THE HANDYMAN

his month's suggestion for the Handyman, while ot being quite so decorative or amusing as some our past efforts, will find a place in many homes, here it will be a good companion in these times of national danger.

HE cabinet has been made as small and compact as possible, easuring 13 inches high, 9 ches wide and 4 5-8 inches ep. The cabinet can have two les drilled in the back, so that can be hung on two hooks ted to the bathroom or other itable wall. Being fitted with handle, it can be instantly de- ched from the wall and trans- rted to the scene of emergency.

Without further ado, we will get on th the job of describing the cabinet. om a piece of ½in. timber, cut the top your cabinet, 9in. long by 4in. wide. is piece should then be cut longitudin- y down the centre and fitted with a itable handle and a small pair of butt nges. Details of the top are seen early in the drawing on opposite page.

A sketch of a suitable handle is shown der the drawing of the cabinet top, ould you care to cut a handle out of a ece of hard wood.

Still using ½in. timber, cut two pieces in. long by 4in. wide for the two sides your cabinet and one piece 8in. long 4in. wide for the bottom. Two shelves e made for the cabinet from ¾in. nber, each shelf measuring 3in. long 4in. wide.

The two drawers have next to be con- dered. From ½in. timber, cut four eces 8in. long by 2½in. wide. Two of ese pieces form the backs of the two awers, the other two pieces are for e two fronts, and should have a ¾in. ameter hole drilled through each so

by

W. G. Nichols

at a finger can be inserted to pull e drawer open when fitted in cabinet.

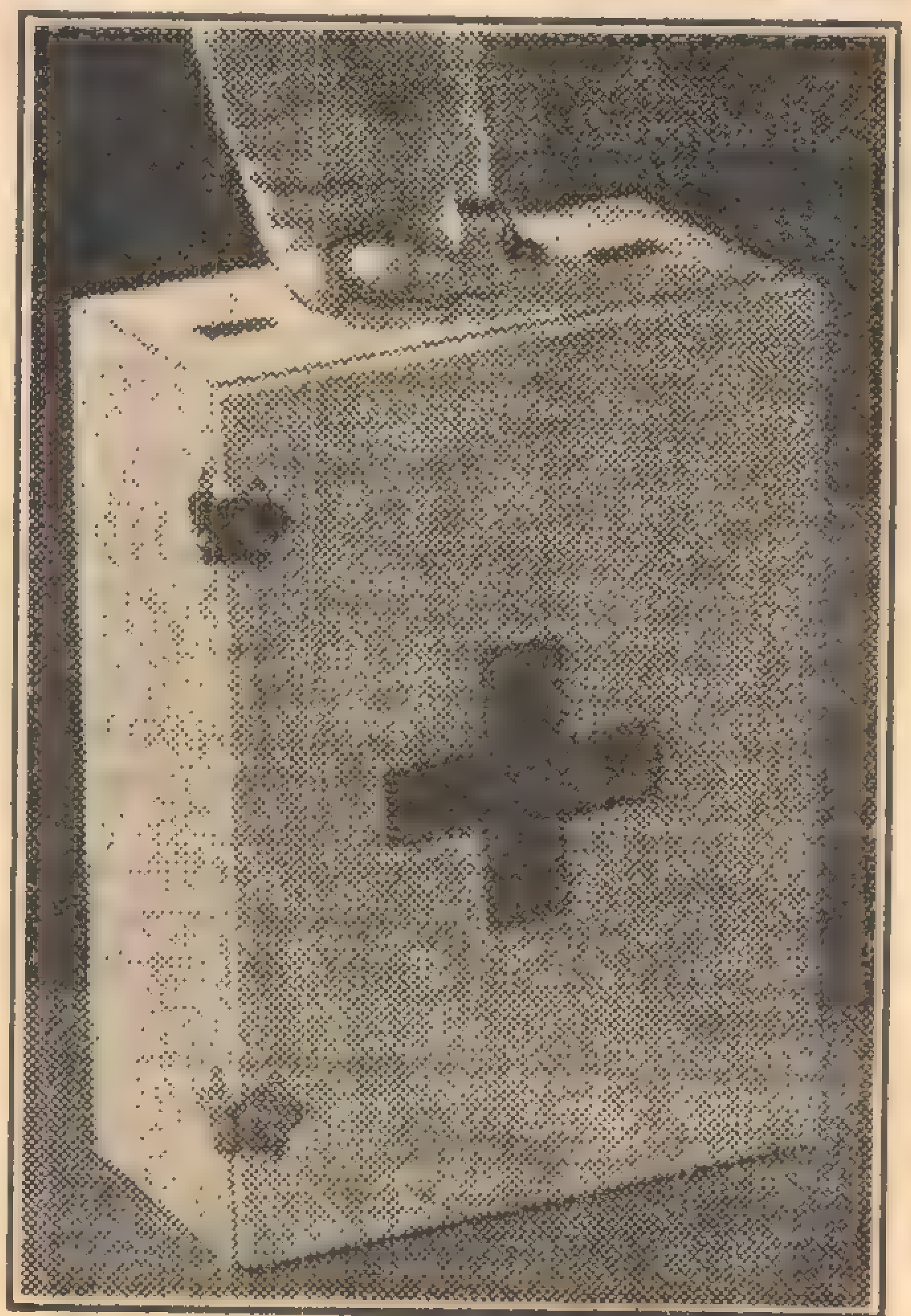
Four pieces should now be cut from n. timber for the four drawer sides. ach piece should measure 3in. long by in. wide. Still using ¼in. timber, cut o pieces for the drawer bottoms, each ece measuring 7½in. long by 3in. wide.

Having cut out the various pieces, ake up the two drawers by referring the sketch headed drawer details. This ows how the various pieces are sembled. 1 is the back, 2 the front, he sides, and 3 the bottom.

Here is the completed first-aid cabinet. Scissors, eye-dropper and tweezers are on the hinged lid. When this lid is swung back it allows easy access to the bottles on the rack. Bandages, lint, cottonwool, &c., are stowed away in the two drawers.

Having completed the drawers, give them a good sanding till nice and smooth, taking care not to round off any of the corners during the process. When completed, stand the drawers aside for the time being.

Getting back to the cabinet, cut a back for it from ⅛in. or 3-16th in. plywood, measuring 12½in. by 9in., and from ¼in. wood a front to the same dimensions as the back, namely, 12½in. by 9in. From the ¼in. timber, cut a piece 8in. long by 4in. wide and cut out three holes each 2in. in diameter as shown in sketch headed container shelf.



The cabinet contains all the recognised essentials for first aid in the home. However, it is quite compact, as seen in this photograph.

Finally, cut from ¼in. timber four pieces 4in. long by ½in. wide, sand, and glue to the two sides of each strip a piece of thin felt, as shown in drawing headed spacer strips.

Now comes the job of assembling the cabinet. This should present no trouble if the builder refers to the assembly sketch shown in the circle on the opposite page. The easiest method of procedure is as follows: Screw the two sides "S" to the base "B," then affix the top "T," making sure to screw the back half only to the sides as the front half has to lift up.

FITTING THE DRAWERS

Next, fit the back securely. Place one of the drawers in the cabinet and then fit the first shelf, just giving the drawer sufficient room to move freely.

Place the second drawer on top of the first shelf, and fit the second shelf, making sure the drawer slides easily. The container shelf is next fitted about 1½in. above the second shelf.

Finally, the front is fitted to the cabinet by means of a pair of nickel-plated hinges. The cabinet should now be given a thorough sanding.

Incidentally, the cabinet has been designed to use three standard peroxide bottles to contain the required chemicals. These bottles measure 2in. in diameter and 5in. in height, so if you decide to use bottles of different dimensions, be sure

(Continued on Next Page)

FIRST AID CABINET

(Continued from Previous Page)

to allow for same when making the cabinet and container shelf.

Having made sure you have removed all traces of dust from the cabinet, give it a couple of coats of white enamel paint, and then mark a neat red cross on the front.

When the cabinet is perfectly dry, turn up the hinged section of the top and glue a piece of felt to the inside, which is fitted with strips of rubber to accommodate a small pair of sharp scissors, a medicine dropper and a pair of tweezers as shown in the sketch headed cabinet top details.

Side hooks are used to keep the hinged section of the top firmly closed, and also for keeping the hinged front closed.

The following list of contents for the cabinet should be found comprehensive enough to cover all cases which come within the scope of the average householder.

Remember, don't take on a first aid job outside your ability, as it may have bad results for the patient.

CONTENTS

1 bottle of antisep, formax, or other reliable antiseptic.
1 bottle of salvolatile.
1 bottle of picric acid.
1 bottle of eye lotion.
1 pair of scissors.
1 pair of tweezers.
1 medicine dropper.
1 packet of lint.
1 packet of safety pins.
2 3in. bandages.
3 2in. bandages.
1 small packet of cottonwool.
1 triangular bandage.

The antiseptic, salvolatile, and picric acid are kept in glass bottles, the scissors, dropper, and tweezers are fixed to the lid of the cabinet and the remainder are stowed in the two drawers.

FIRST AID HINTS

SHOCK follows most injuries and is a state of nervous depression following an accident or injury. To relieve shock (1) arrest any severe bleeding, (2) lay patient down and loosen clothing around neck and chest, (3) keep patient warm and speak reassuringly, (4) administer salvolatile to patient's nostrils.

BURNS

Keep air away from burns by applying 9in. lengths of bandage soaked in picric acid till the burn is completely covered. The idea of cutting the bandages into 9in. lengths is to assure only small sections of the burn are exposed to the air when redressing.

Carefully remove clothing from injured parts. But, if clothing sticks, cut it round the edges of the burn, soak picric acid and bandage.

When treating cuts and open wounds, they should be cleaned as well as possible with warm water and then dabbed with small pieces of cotton-wool dipped in antiseptic before dressing with lint and bandages.

Having made your first aid outfit, I will leave you with the wish that you will never have the need to use it.

JOE'S COLUMN

THIS month I intend to tell you about one of the most interestin' of all metals. At any rate, at the present time it is one of the most important in aircraft production, and that means somethin' today.

It is magnesium, a wonder metal—a Jekyll-Hyde metal. It's a third lighter than aluminium, and when mixed with copper, manganese and aluminium in very small quantities its strength-weight ratio is higher than that of duralumin—a metal that I told you about recently. To pick up a sheet of it is like pickin' up a sheet of paper.

The demand for it by aircraft manufacturers is colossal. During the whole of 1939—the year war came—the USA only produced 3000 tons. The fall of France spurred them on to produce 6000 tons in 1940, 15,000 in 1941, and during 1942 they expect to produce 45,000 tons and ultimately more than 60,000 tons a year, and it's nearly all to go to aviation.

One maker of aeroplane engines estimates that they save 91lb. of weight on each 14-cylinder engine by usin' magnesium alloy in place of aluminium alloy for various components. On a four-engine job that is about equal to the weight of two extra crew members.

The magnesium alloys were first developed by the Germans during the last war because they couldn't get aluminium, and the most familiar one known is elektron. It is bein' extracted from a mineral known as magnesite, and also is obtained from brine wells, and believe it or not, in the USA it is bein' extracted from sea water!

It has another feature besides extreme lightness that can be very terrifying—fire! Magnesium is a metal that has to be machined very carefully, otherwise it may flare up. Shavin's from it will ignite readily and burn with a fierce white flame. In an incendiary bomb it is magnesium metal that burns and causes the damage and even water won't put it out—only sand. These bombs, bein' so light are carried and dropped in large numbers. A single plane may carry anythin' from 1000 to 2000 bombs.

But like everythin' else they're learnin' to control it. When in its molten state and the liquid metal is bein' poured into a sand mould to make a castin' it is particularly dangerous, but it is tamed by a workman continuously sprinklin' it with a mixture of sulphur and boric acid. This excludes the oxygen and therefore prevents it from burstin' into flame.

A reasonably thick piece will not burn readily, but veteran photographers well remember the blindin' light of burnin' magnesium.

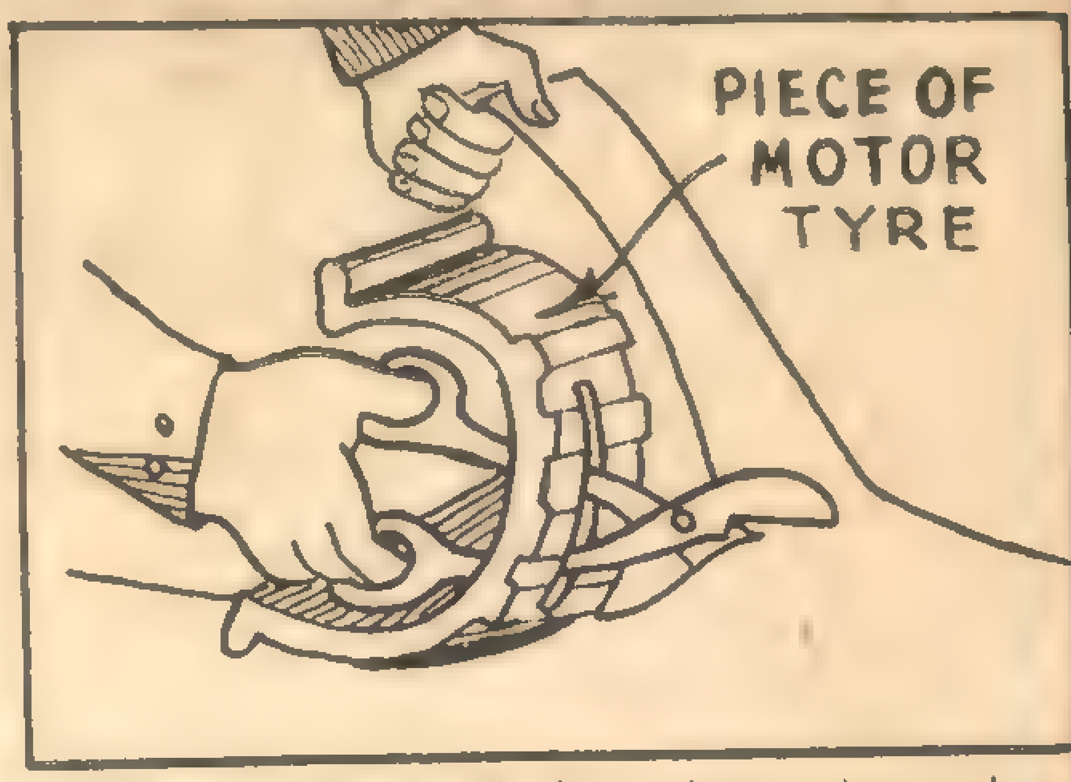
STATIC ELECTRICITY

According to recent tests in USA, charges of static electricity amounting to 12,000 volts or more may be built up on automobiles driving along dry roads. It is, however, only under exceptional circumstances that the occupants of the car become aware of it.

THE EASY WAY

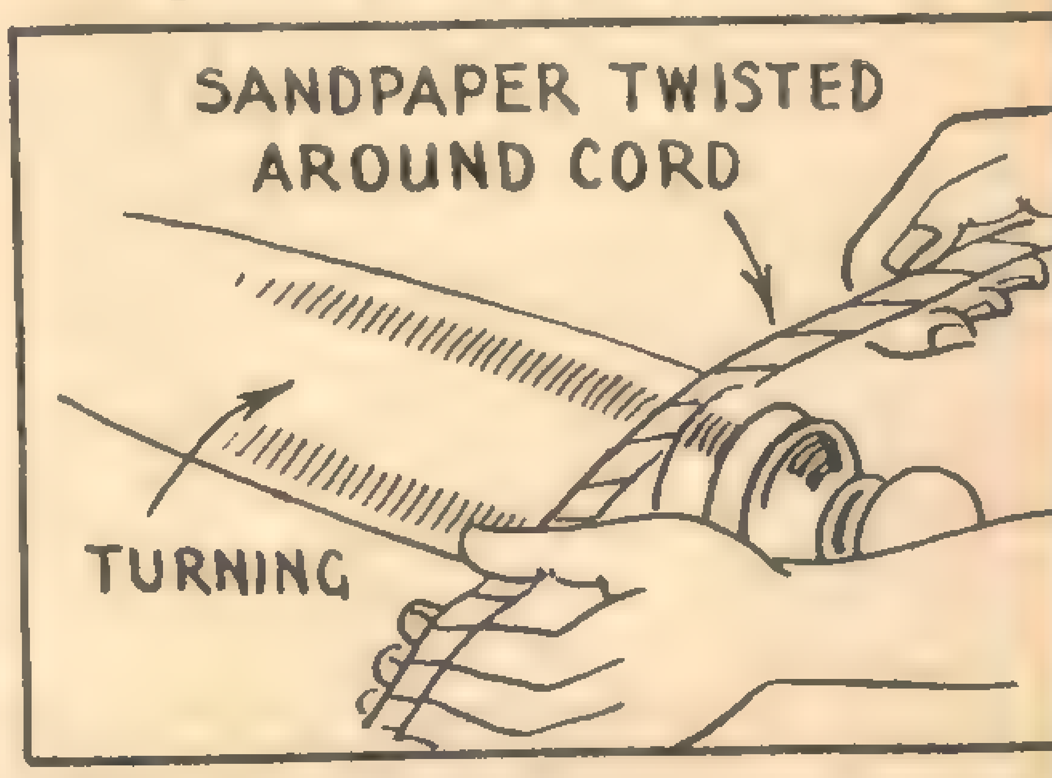
By WALTER G. NICHOLS

HAND SHIELD



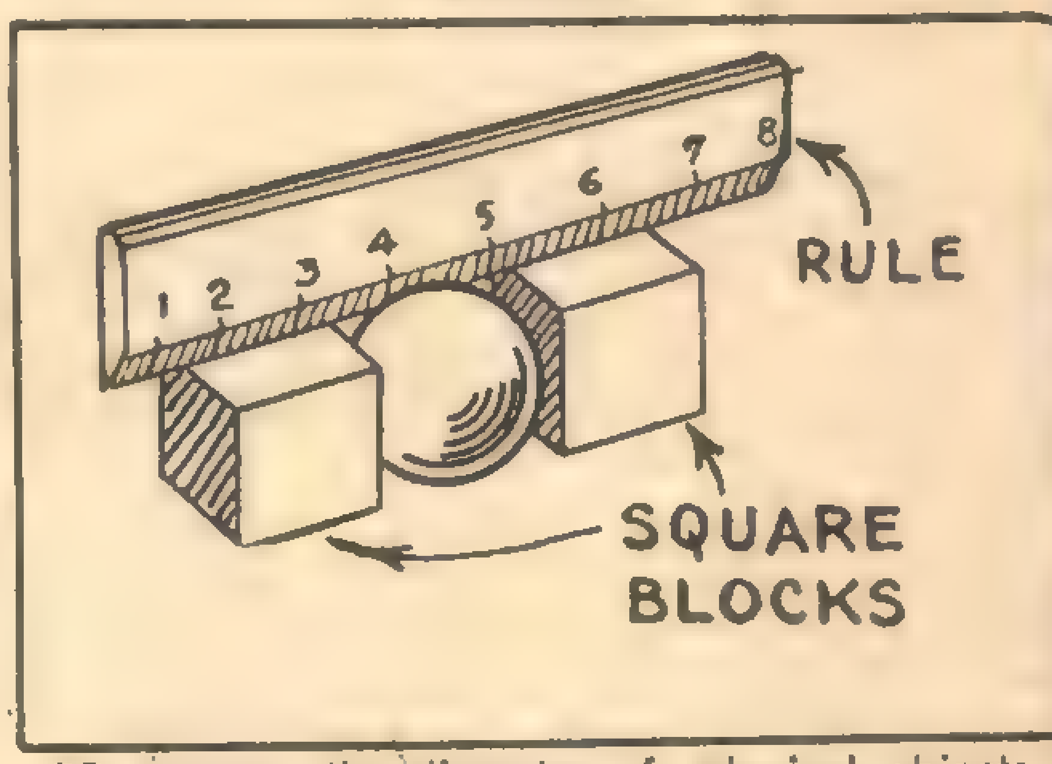
TO protect the hands from sharp edges, when cutting sheet metal, slip a piece of light motor tyre over the tin snips, as shown. Make a slot in the tyre large enough to allow free action of the snip blades.

SANDPAPERING HINT



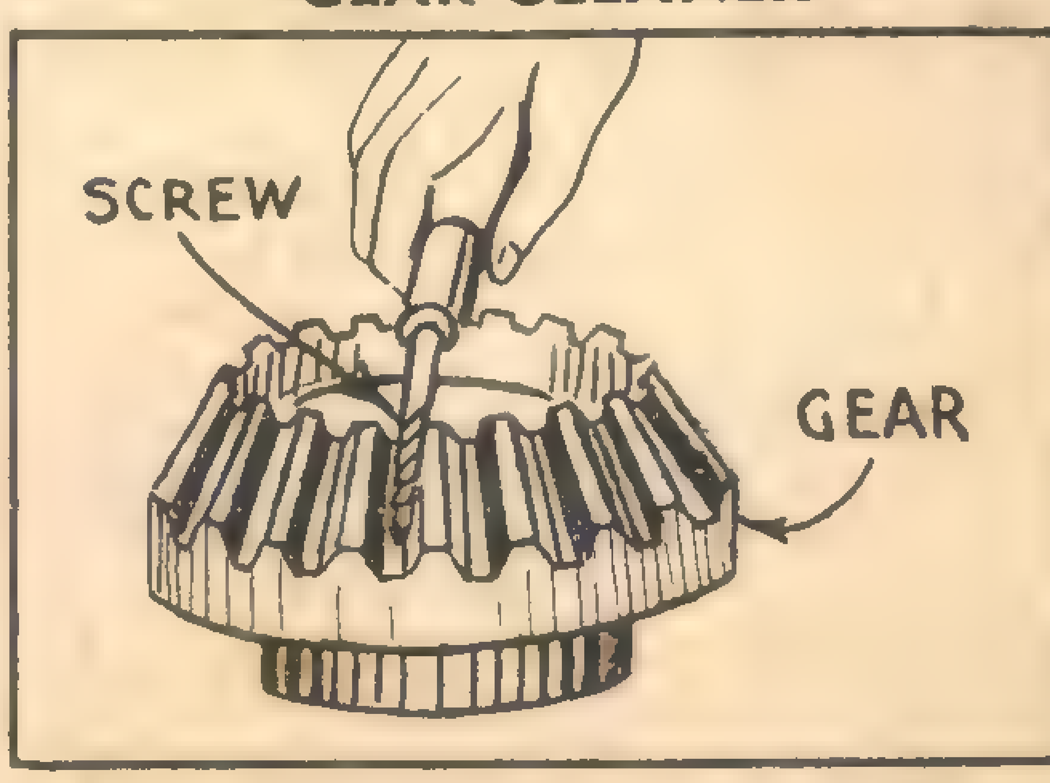
FOR sanding irregular surfaces on wood turnings, twist a narrow strip of sandpaper in a spiral around a stout piece of cord, as illustrated. This provides a flexible abrasive surface that gets into narrow grooves.

MEASURING DIAMETER OF BALLS



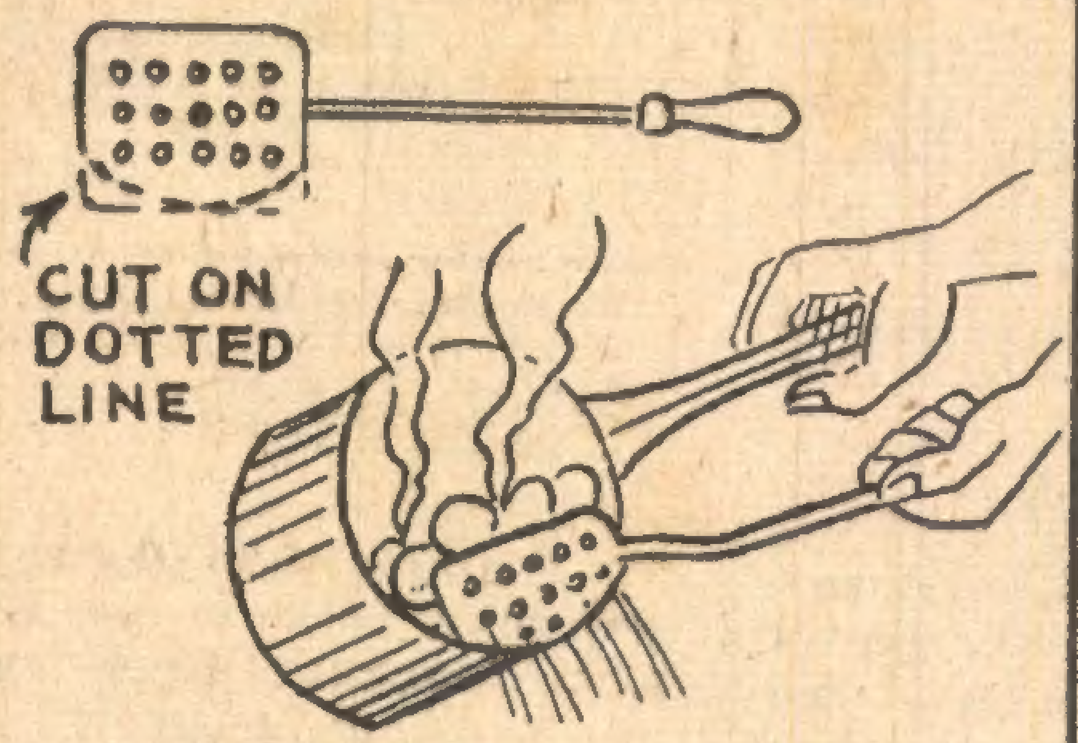
TO measure the diameter of spherical objects, place them between two blocks and measure across the tops of the blocks. For accurate measurements, the sides of the blocks must be 90 degrees to their bases.

GEAR CLEANER



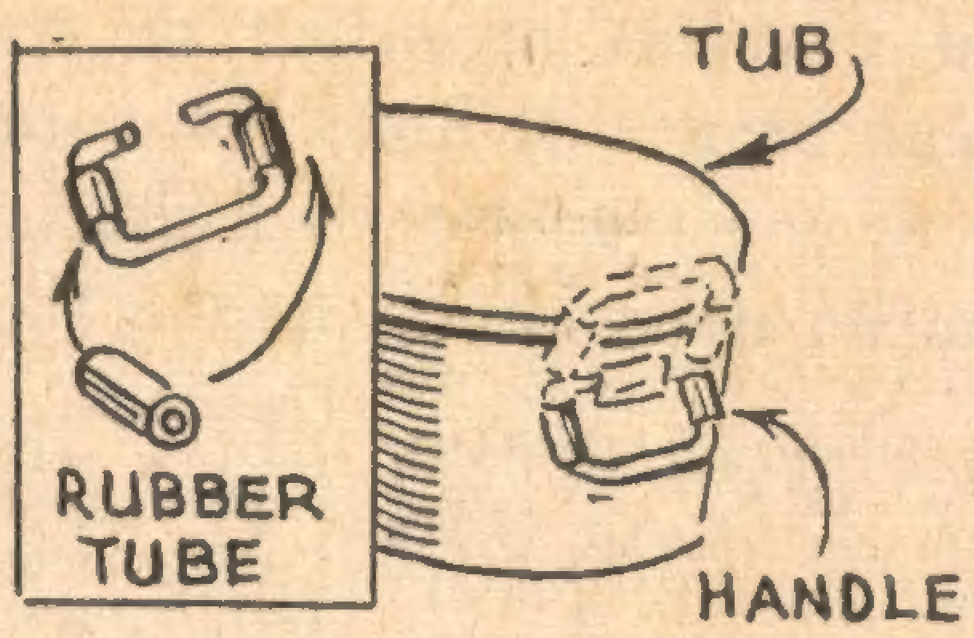
GEARS full of grease and dirt can often be cleaned without dismantling the parts. Obtain a long wood screw, cut off the head, and set the shank in a file handle, as shown in accompanying drawing.

USEFUL HINTS FOR THE HOME HANDYMAN



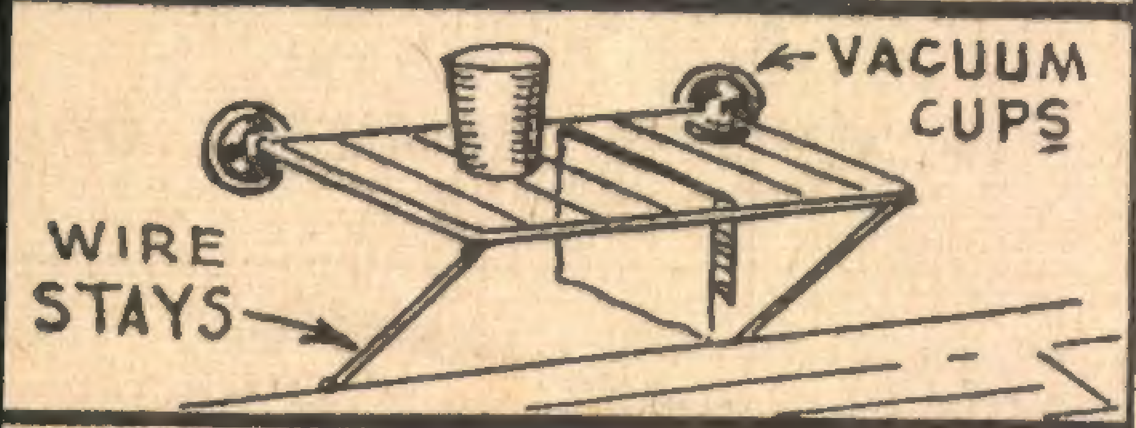
VEGETABLE DRAINER

With the lower edge cut to curve as shown in sketch, a perforated egg-slice or cake turner makes an ideal vegetable drainer. The rounded edge allows it to sit snugly into the pot and the long handle keeps the hand away from the steam.



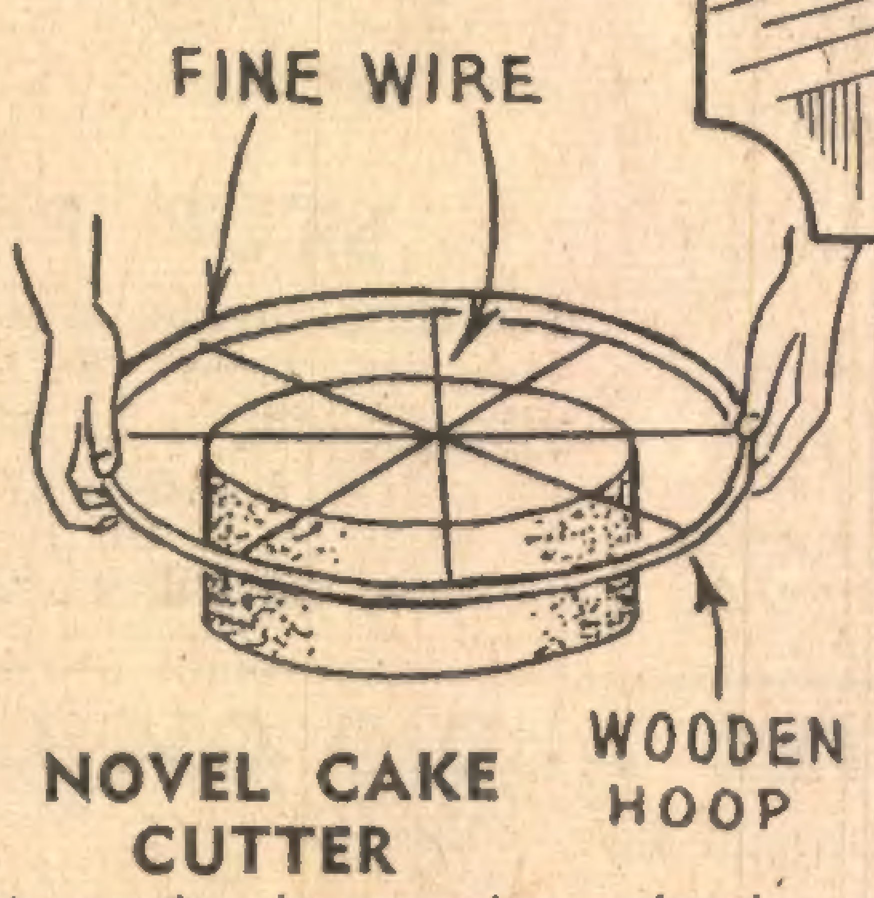
KNUCKLE SAVING BUMPERS

Wash tubs may be carried without squeezing your knuckles if the handles are fitted with short lengths of rubber hose, as illustrated. The rubber presses on the rim of the tub and prevents the knuckles from being squeezed.



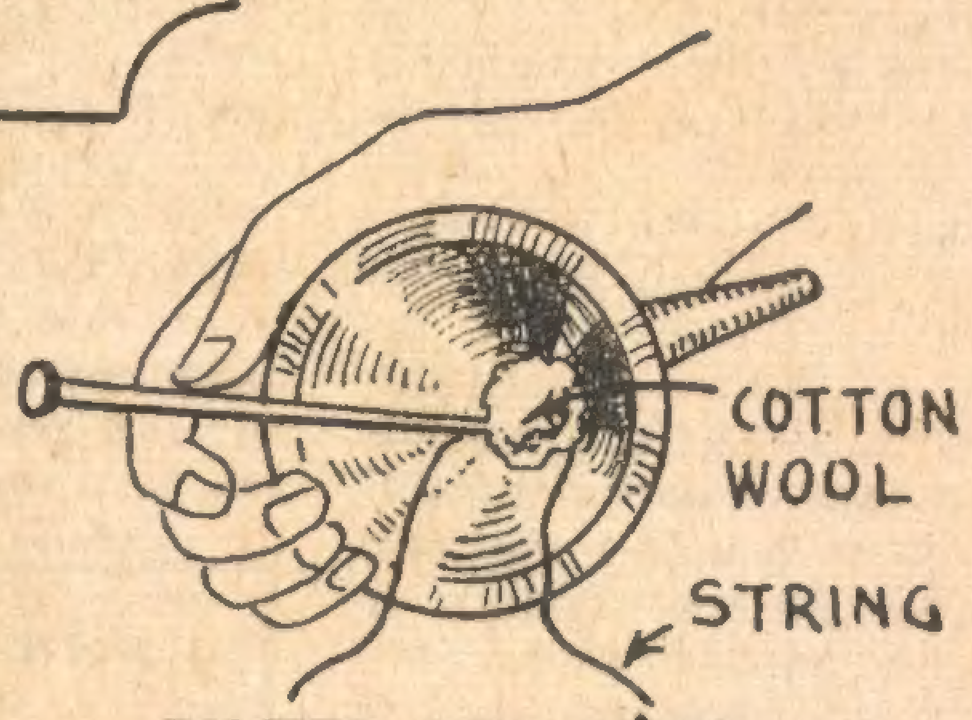
ADJUSTABLE SHELF

Hinged to the back of a sink by two vacuum cups, a wire shelf from an ice chest serves many purposes. In lowered position it makes a draining rack for plates. Held horizontally by two wires, it serves for drying cloths.



NOVEL CAKE CUTTER

A wooden hoop makes a handy cake-cutter. Holes are drilled around the edge and thin steel wires are passed through the holes, stretched tightly and fastened. Pressed firmly down on a cake, it will cut it into neat, even slices.



FILTER REMOVER

Cotton wool, pushed into the neck of a funnel as a filtering medium, can be removed without soiling the hands. Place a piece of string in the funnel neck. Pulling ends of string removes cotton wool.

BROADCAST BAND DX

by Roy Hallett

Since the very first issue of Radio and Hobbies, it has been a matter of policy to provide, each month, the best possible information for short-wave listeners. However, we have often wondered how many of our readers are interested in long distance and overseas reception on the broadcast band. Here are some broadcast band DX notes, compiled by Mr. Roy Hallett. If you are interested, drop us a line and we will see what can be done about making this a regular feature.

MANY radio listeners, seldom, if ever, try to receive overseas stations on the Broadcast band, many of them don't believe it possible. I live eight miles from the heart of Sydney, and on my 6 valve receiver, made from a circuit described in "Wireless Weekly," in 1936, I have heard stations on every continent, with the exception of South America and Africa.

It is not always possible, unfortunately, to receive long distant stations, as some locations are unfavorable for such reception. A fairly good aerial is essential. However, I heard KGMB Honolulu, Hawaii, one night on a three-valve 1928 model receiver, with the aerial attached to a branch of a tree outside the window.

VERIFICATION CARDS

The majority of these stations, like the short-wave stations, send out verification cards or letters. Some of these cards are very attractive, and some interesting literature and letters have been received by the writer, and other DX'ers I know, from medium-wave stations both in this country and overseas. Australian medium-wave stations also send out cards and letters. Many of these cards are well worth having.

Stations on the broadcast band are seldom as strong as those heard on short-waves. It is, however, possible to follow a news bulletin fairly easily from American, Asiatic, European, and, of course, many New Zealand stations. Under favorable conditions, stations in these parts of the globe reach good signal strength, and some musical, or other types of programmes, may be thoroughly enjoyed.

REPORTS WELCOMED

Reports from our readers concerning their reception of broadcast band stations overseas would be very welcome. Your criticisms on this section and any questions you may have to ask concerning this hobby would be greatly appreciated. Please address your communications to the writer at 36 Baker-street, Enfield, Sydney.

IF you are keen on Broadcast Band DX, you are invited to send in reports of stations received and other relevant news to Mr. Roy Hallett, who is responsible for compiling this material. Letters may be addressed direct to Mr. R. Hallett, 36 Baker-street, Enfield, NSW. Alternatively they may be addressed C/o Mr. W. N. Williams, Technical Editor, Radio and Hobbies, 60-70 Elizabeth-st., Sydney.

Here is a brief summary of stations likely to be heard in Eastern Australia during the next month or so.

NORTH AMERICA

Stations in North America are being heard at present after our local stations close at night, leaving clear channels, till they fade out at about 1.30 a.m.. These are usually the best of them:—

KFI, Los Angeles, 640kc. Fairly strong, but interfered with by a Chinese station.

KPO, San Francisco, 680kc. One of the best of these, fairly good around midnight and 1 am. It is fairly consistent.

KOA, Denver, 850kc. Fair, with news at midnight.

KIRO, Seattle, 710kc. Fair around 1 am.

KNX, Hollywood, 1070kc. Fairly good from 12.30 am, fades around 1.30.

KSL, Salt Lake City, 1160kc. Opens at fair strength, 11 pm.

WOAI, San Antonio, 1200kc. Fair between 11 and 11.30 pm, sometimes later.

ASIA

Asiatic stations are heard best during our winter months, but the following are audible at present. These broadcast native type programmes, but the 11.30 news from Dacca is in English.

XGAP, Peking, China, 640kc. Fair from just after midnight till a few hours later, when it closes. Sometimes spoilt by KFI.

XOJC, Nanking, China, 660kc. Not very strong, heard around midnight.

HS7PJ, Bangkok, Thailand, 825kc. Fair around 1 am.

VUY, Dacca, India, 1167kc. May be heard with news relayed from Delhi at 11.30 pm favorable nights; audible till around 3 am.

NEW ZEALAND

The easiest of the overseas countries for Eastern Australians to hear on the broadcast band is our Sister Dominion New Zealand. Some excellent signals are available from NZ now at night. Try these:

2YA, Wellington, 670kc. News 8 pm closes 10.30 pm.

1YA, Auckland, 650kc. News 8 pm closes 10.30 pm. A relay is taken from the BBC at 10 pm.

2YC, Wellington, 840kc. This station apparently closes down at 9.30 pm.

EUROPEAN STATIONS

European stations are heard at quite good strength just before sunrise during our summer months. Some are likely to be heard for a while yet. Incidentally, Europeans as a rule don't use call signs on medium waves.

Radio Sofia, Bulgaria, 850kc.

English National stations, 1149kc., often taking the BBC service to Europe, heard on the SW European service stations.

Nice, France, 1186kc.

Rome, No. 2, Italy, 1222kc.

Rome, No. 1, 713kc.

Breslau, Germany, 950kc.

Konigsberg, Germany, 1031kc.

These are usually heard from around 4.30 am till sunrise.

STOP PRESS

The times quoted in each case are daylight saving times. It now appears that daylight saving is to be discontinued as from April 1, and due allowance will need to be made for this. Subtract one hour from all times quoted.

AN A-C OPERATED AUDIO OSCILLATOR

(Continued from Page 45)

In the original oscillator, the components were assembled on a chassis which had been designed to house an a-c power unit for a portable battery receiver.

After making a cut-out for the speaker with a hacksaw and after cutting out a hole for the extra valve, the chassis served the purpose very well. The case did not have a fret for the loud speaker but this difficulty was overcome by drilling a series of small holes in the appropriate place.

You will notice that the loud speaker transformer used was larger than the size usually employed with a five-inch speaker. You will notice also that it was mounted beneath the chassis. As explained earlier, this exact procedure need not be followed and a speaker may be used with its normal transformer in position, provided that the latter is of suitable design.

However, all these points can be clarified with the exercise of a little ingenuity.

NSWERS TO CORRESPONDENTS

NDER THE PERSONAL SUPERVISION OF THE TECHNICAL EDITOR

RADIO AND HOBBIES INFORMATION SERVICE

FOR the benefit of our many readers, we maintain two distinct information services. The first of these, conducted on these pages, is open to all and is quite free. If you have a problem which is bothering you, write in to us and we will do our best to give you the answer in the next issue.

However, remember that our issues are on sale at the beginning of each month and that they go to press in the middle of the preceding month. Therefore it is wise to get your queries in during the first two weeks of each month.

For those who cannot wait until the end of the month for the answer, there is the "Shilling Query Service." If you send in your query, accompanied by a postal note for one shilling, we will answer your query by letter as quickly as possible. You will understand that, with reduced staff, such letters have to be attended to when the opportunity occurs.

Make your letters brief and to the point. If you can number your questions, so much the better. Do not ask for special circuits or layouts, as these take too much time to prepare. Very simple circuits can generally be sent, but we must be the judge in this matter. If we cannot oblige, your money will be refunded.

Make your postal note payable to "Radio and Hobbies," and address your letters to the "Technical Editor, Radio and Hobbies, 60-70 Elizabeth-street, Sydney, NSW."

.J.N. (Hamilton) is having trouble in reducing the output from a modulated oscillator, ch he has constructed.

: It is always quite a problem to control output of a modulated oscillator, particuy when operated from the supply mains. simply becomes a matter, by means of ring and shielding, of preventing r-f radia-, except by way of the attenuator. As ch as we would like to help you, we not say more than has already been said the article on the subject and in the wer to a correspondent in the Christmas e.

.D. wants to know how to recharge "B" teries.

: Sorry we cannot help you directly, but noticed an article on recharging "B" batteries the February issue of the "Australasian io World," and we suggest you write to n and ask for full particulars.

.F. (Queensland) wants a copy of the Christ- issue of "Radio and Hobbles."

: If you care to use our shilling postal ice we will be glad to forward the Christmas e to you.

M.W. (Point Cook) has just been introduced "Radio and Hobbies" and was greatly interd in it, also he wants a circuit diagram of tle Jim's Mate."

: We are very pleased to hear that you "Radio and Hobbies" so much. If you our shilling postal service we will be to send the circuit that you require by rn mail. Thanks for the encouraging arks.

.M. (Glebe) has recently built-up the 1941 l Wave Advance and sends in the following orable report:

s an all-round set it is very efficient as eceives 2WL, Wollongong, 2KA, Katoomba, many interstate stations at good strength daylight. On the short-wave band the ption is excellent, having received many ions in London, America, Japan, Manila, in, and Rome, all with good signal strength. ions picked up by the Dual Wave Advance extremely clear. "I cannot praise this iver too highly," says our correspondent.

H. (Dubbo) is an interested reader of "Radio Hobbies," but feels that we have rather ected the short-wave fan. He would also to see included a course of instruction the AOPC examination.

Thanks for the letter. We note your arks re short-wave receivers and will keep r request in mind. We scarcely think that special series of articles for the AOPC mination would be warranted at the moment, cially since it would mean dropping other ures of more immediate interest.

J.W. (Gibsonvale) cannot get results from Duplex Single.

Do not take our remarks in the letter seriously. Whatever its limitations as rds range, the Duplex Single should give something more than crackles, especially at night. With the set oscillating you should be able to hear plenty of "joeys" as you turn the dial. If you cannot, the receiver is obviously not operating as it should. The fact that you get a lot of crackles might indicate that there is a poor connection. It is impossible to suggest where your trouble lies because there are so many likely causes. Maybe you can enlist the help of a friend with a little more experience. Anyhow, let us know how you get along and we will do our best to help you further if you have no success.

R.S. (Bioela) makes the suggestion that, in the present series of public address articles, we include one or more circuits intended particularly for operation from accumulators and vibrators or genemotors.

A: Thanks for the suggestion. Yes, we definitely intend to do something along this line. However, there seems to be so much to write about and so little time and space that it is not possible to indicate just when the article in question is likely to appear.

J.W. (Toorak) has been reading "Radio and Hobbies" and has become interested in radio. Accordingly, he wants to get hold of one or more suitable text-books on the subject.

A: We suggest that your best plan would be to go along to McGills Agency, Elizabeth-street, Melbourne, and see what they have on their shelves.

J.H. (Dural, NSW) would like to see us describe a simple one-valve receiver and then to describe additions month after month.

A: This is a very good scheme, which has been put into practice by various journals. We may be able to see our way clear to do something like this later on, but it cannot be for the next two or three months. Your subscription has duly been noted.

J.W.S. (Hawthorne, Q) has a TRF short-wave receiver which does not perform very well in daylight. He would like to substitute more modern valve types, but is not keen on the prospect of making changes to the wiring.

A: The sensitivity of the type of receiver you have is limited. However, we are inclined to believe that the failure to hear stations at certain periods is simply due to changing reception conditions. Watch the short-wave notes for hints in this regard. If you want to substitute more modern types of valves, it will be essential to change the sockets. However, we do not think that it would make any startling difference to the performance. Thanks for the nice remarks.

W.T.L. (Sandford, Tas.) has built up the "Little General," using the 6F7 in order to obtain more gain. Results are excellent, but the volume control tends to be rather sudden in its action.

A: It may be that the volume control you are using is of too high a value. The value specified for this circuit in the October 1940 issue was 5000 ohms. If you find this value higher than necessary for your particular location, it could be reduced still further to about 2500 ohms. The idea of varying the bias on the 6V6-G is quite wrong and may cause damage.

X-Tube (Bentleigh, Vic.) has a Rogers 6H7-M valve and wants to know what it is.

A: According to the information at our disposal, the 6H7-M is a multiple valve incorporating a triode unit similar to that of the 6B6-G and a power output pentode similar to the 6F6-G. It apparently does not include any diode units. As you will observe, it is equipped with an octal base and has a metal-sprayed envelope. Sorry, we cannot give you the base connections. Thanks for the encouraging remarks. We are doing our best to keep "Radio and Hobbies" up to the mark in these difficult times.

R.G. (Hahndorf) is having some difficulty with the radiogram 8. He also wants to add bandspreading to the receiver if possible.

A: As you have already had the receiver checked over, apparently without much success, by a firm specialising in radio repairs and service, there does not seem to be much hope of us picking the trouble. The instability on 910kc. is probably the result of coupling between the aerial and I-F circuit and it may be rather hard to overcome. Keep the aerial terminal and lead well away from the I-F channel.

The hum you describe may be mechanical vibration of the transformer laminations, in which case tightening up the mounting bolts may be a help. We suggest you read through the articles on "Hum" in the June and July issues. To overcome the instability between 1360 and 1380kc., try the effect of additional bypassing on the various screen and cathode circuits and from B plus to earth.

Bandspreading is a big subject and we have not yet had the opportunity to look into the possibilities from the point of view of the home-builder. The problem is not so much one of bandspreading. Rather it is to achieve frequency stability, which becomes ever so much more important when the bands are spreading over a larger expanse of dial scale. Your experiences with the I-F transformers should make clear the pitfalls one is likely to encounter in this regard.

C.B.M. (Cooyar, Q'ld.) asks some general questions.

A: You appear to have your terms for voltage and current rather mixed and your query is consequently rather hard to follow. It is quite in order to use 90 volts with type 19 valve in the circuit in question. If a regenerative detector fails to oscillate over the whole of the band, the trouble can usually be overcome by adding a few turns to the reaction winding, by increasing the coupling between the two windings or by increasing the supply voltage, if that is permissible and convenient. It is assumed that the valve is in good condition and that the value of the reaction condenser is adequate. It would need to be about .0001 mfd. Thanks for the subscription, which has duly been attended to.

J.W. (Toorak) is interested in radio and would like a good book on the subject.

A. As you live in a suburb of Melbourne, we suggest you call in at one of your local booksellers and see what they have on their shelves. We suggest McGills Agency, 183-5 Elizabeth-street, Melbourne.

E.M.C. (Victoria) recently built the Dual Wave Pentagrid 46, but finds that the converter will only oscillate when the A battery is fully charged. He thinks that the coil kit that he obtained is for an A-C set.

A: As you suggest, the trouble may be due to the coil kit. However, you may be able to overcome it by incorporating padder feedback, as used in the 1942 Pentagrid Four, described in the March issue of "Radio and Hobbies." Failing this, we can only suggest you take the matter up with the coil manufacturers, as the matter is really between you and them.

L.P. (WA) asks for the September and Xmas issues of "R. and H." He also wants to buy some parts.

A: The Back Dates Department informs us that both these issues are still in stock, the prices being one shilling, and eightpence, respectively.

As we do not sell parts for our sets, we suggest you write to one of our advertisers in this regard.

RM (Guabega, NSW) states that he has never been able to obtain reproduction of records from a pickup in the usual fashion to equal the reproduction of the same records over the air. He wants to obtain a circuit of a pickup oscillator to feed the signals to the receiver via the aerial terminal.

A: Owing to the loss of high frequencies in almost any radio receiver, the reproduction of records heard over the air is usually poorer than that possible by playing the same records straight into a good amplifier. If it is the lack of high frequencies which pleases you, you can get the same effect by putting a heavy bypass condenser across one of the plate circuits. We strongly suggest that you forget the idea of the pickup oscillator, as this constitutes a form of transmitter, and you may find yourself in difficulties with the military authorities.

J.A.W. (Bendigo) would like to see some articles on photography. He has also built up a one-valve receiver which howls when the reaction control is advanced.

A: Thanks for the suggestion, but as there are publications that specialise in photography, we are doubtful as to the necessity of such articles.

We cannot understand why your receiver should not operate as it should, since the circuit seems to be quite straightforward. We notice, however, that you are only using 1.5 volts for the filament of the 19, whereas the actual filament voltage is 2 volts. This may have some bearing on the poor sensitivity.

Here are a few alterations that could be made to the circuit.

(1) Bypass the junction of the r-f choke and the primary of the transformer to earth with a .00025 mfd. condenser.

(2) Increase the reaction control potentiometer to about 50,000 ohms.

(3) Finally, try reversing the connections to the primary of the transformer.

A.N.R. (Tewantin) is not keen on tone controls in radio receivers, and has accordingly submitted a modified version of the "1942 Pentagrid Four" circuit, omitting both the tone control and the negative feedback.

A: The modification would probably be OK, although the audio gain would now be very high. You could, of course, use the negative feedback without the tone control arrangement. The 2 mfd. condenser in place of the 25 mfd. electrolytic may or may not give sufficient filtering and the only way to find out would be to try it.

H.L.P. (Victoria) recently built up the "R & H" "Communications 5," which gives excellent results. He is, however, rather worried because the 5in. speaker overheats.

A: As the circuit stands, the field wattage dissipation is rather high for your small speaker, which accounts for the overheating. It may help matters to substitute a 250 or even a 300 ohm. resistor, as the bias resistor for the 6V6-G, instead of the 150 ohm. resistor, as shown in the circuit.

R.G. (Picton, NSW) has a comparatively modern receiver which has a "rustling" noise in the output, even when the volume control is turned off.

A: The various tests you have described localise the trouble and we suggest that it is caused by a noisy resistor in the plate circuit of the first audio amplifier. Failing this, see if you can borrow another loud speaker for a test. The output transformer may be failing.

SHORT-WAVE REPORTS

Mr. J. Buckley (Goulburn, NSW).—Your numerous letters regarding the 25-metre band loggings were greatly appreciated, and between us both they now seem to be sorted out. I have already written you regarding the other matter, and hope it will soon all be settled.

Mr. L. Walker (Applecross, WA).—Many thanks for the copy of the Broadcaster, which interested me very much. Have already written you about your article, and, as you will see, it is now published in this issue. I expect you will be interested in the frequencies of the USA stations, which I hope will also be in this month's issue.

Mr. B. W. Battis (Coraki, NSW).—Mank thanks for your letter, and I expect that by now you are well and truly in camp. Quite a number of our listeners find time to do a bit of listening while stationed in favorable positions, so hope you also will be lucky. Congratulations on your cards from HCJB, XGDN and YDB, and hope a few more turn up to keep your interested. Kind regards and good luck.

Mr. R. K. Clack (Beresfield, NSW).—You certainly get some moving around all right and hope the new location proves a good one. I now seem to have been successful with my verifications from XGOY, thanks to your help. Yes, you should have received your card from VPD2, but it may turn up one of these days.

Dr. K. B. Gaden (Quilpie, Qld.).—Many thanks for your kind letter and I know you would have helped if it had been at all possible. You will certainly be busy at Quilpie, and will miss the daylight stations in the winter when you have to be away. I hope to have written to you before you read this Kind regards.

Mr. L. R. Suleau (Roseville NSW).—I quite agree with you that it is now very disappointing not to be able to hear the familiar voices from the Asiatic stations, but they will return, never fear. Daylight saving has certainly made a difference to early morning listening, and has made many more stations audible.

Mr. G. Jones (Seymour, Vic.).—Very pleased to hear from you again, and also interested to know you are now in camp. Your write-up concerning your many amateur QSL cards was exceptionally interesting, and I will see if I cannot make it up into a short article for one of the issues. All the best and kind regards.

Mr. B. W. Battis (Speers Point, NSW).—Well, you are yet another of our readers to be in camp, and I hope you will still find time to do a bit of listening when you get the chance. Many thanks for the list from India, and, funny enough, I got one myself last week. I have had no luck with verifications from Delhi myself, but will write again in the near future.

Mr. A. S. Condon (Laura, SA).—One of the best reports for the month, as it is full of interesting information. Have had one or two reports of broadcast band Americans this month, so will have to try for them myself. Sorry you have not hard your R. and H. regularly, but hope it will improve from now on. Kind regards.

Mr. Gordon Obey (Bronte, NSW).—Many thanks for your letter, and was very interested in your broadcast band DX achievements. No. I have never done very much in that line myself, but must have a listen one of these nights. You have certainly got a nice line-up of verification cards, and hope you will receive many more in the future.

Mr. H. Perkins (Malanda, Qld.).—You still appear to be hearing most of what is on the air, and have a good log as usual. Best of luck in your efforts to join the RAAF. The station you thought to be an African on 50.2 m. would be radio Cairo, I think, rather than a South African, though the announcement sounds like one of the latter.

Mr. A. Lee (Newcastle, NSW).—Interested to hear you had been transferred to Newcastle, and will try to see you one Friday when I am in that city. My telephone number is B1928 Newcastle when I am there, that is. You will miss your receiver all right, but will have plenty of other things to occupy you for some time.

Mr. T. Whiting (Five Dock, NSW).—Was very pleased to meet you, and hope that by this time the various negotiations have been successfully carried out. However, you will know about it long before you read this issue of the magazine.

Mr. A. E. Moore (Brisbane, Qld.).—Sorry to hear about the injury to the eye, and hope it is completely healed now. Yes, I can imagine you were very pleased to receive the card from OAX4J, and hope it will be the forerunner of many more. Regarding the receivers, I would suggest the latter make, as I have also heard some poor reports of the firstnamed, though I have had no persona experience of either make.

Mr. E. L. Fleming (Burwood, Vic.).—I wa certainly pleased to hear that R. and H. ha at least turned up, and trust that it wil arrive regularly from now on. Your statio just above WRUL would possibly be OFE i Lahti, Finland, but could also have bee DJD. Am afraid that verifications from th Asiatic countries are now finished until afte the war.

Mr. G. Smart (Sth. Caulfield, Vic.).—You letter arrived on the Monday afternoon mai being postmarked the same day in Melbourn 4.30 am, so this is quite in order to sen this way. Yes, it is very disquieting to hea of the well-known stations leaving the ai but they will return some day, never fea XYZ is still going as we write this, but onl from 11 pm till midnight.

Mr. M. Foster (Mount Vincent, NSW).—Yo are certainly busy with your VDC work, an quite understand that you will have little tim for writing, but a line now and then is alway appreciated. Glad to see the typewriter stil seems to be working all right.

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